Hahai: Computational Thinking in Primary Schools

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Abstract. Nowadays, society needs to keep up with the development of new technologies; the children of the new generation are seen as "digital natives", although they are not necessarily able to use digital devices to their fullest potential.

The "Hahai project" introduces the application of digital devices within the educational approach throughout the Hahai app. The aim of the project is to introduce digital skills and computational thinking through "Digital Storytelling" in primary schools; with the aim of developing problem-solving and the creative approach. Furthermore, these skills are extremely valuable in modern society and for the future.

This paper explores the ideas behind the creation of the project, the development of the app, the testing in first-grade classes of primary school, the statistics obtained from the latter and the final conclusions.

Keywords: Computational thinking · Advanced teaching · Digital storytelling · Apps

1 Introduction

This document aims to identify a possible solution to what is now needed in society: being able to manage the continuous development of technologies in all the areas of the said society. The new generation, hence children considered *"digital natives"*, are familiar with the use of digital devices often before being introduced in school. But the problem is their lack of awareness of the devices they use easily. Empowering them is becoming a formative social necessity.

The definition of "digital natives" is just an incorrect term assigned by society to those born in the new millennium [1]. However, although children's digital literacy seems to be an advantage, it could be an issue: parents and teachers often rely on technology and leave the "digital native" without support.

Statistical data shows that, paradoxically, children are the first to be exposed to danger: they do not have the necessary skills required in the *Digital Age*.

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The *AICA* [2] collected statistical data and showed that the gained skills create a wrong awareness of skills that aren't present and that are incomplete.

The ICILS (Computer International and Information Literacy Study) shows that 17% of eighth-grade students do not reach the minimum level of digital knowledge and only 2% of students have full skills in the subject. The worst thing is that 84% believe to have "good"/"great" digital knowledge, but practical tests show that 49% achieved "bad"/"terrible" results.

Young people, without formal education and training, cannot gain the digital skills they need on their own.

Unfortunately, digital devices and smartphone applications are considered by digital natives as a hobby and not as something they will have to live with.

School, as an educational establishment, has the responsibility to instruct young children about digital literacy. Nevertheless, it is necessary that competent adults develop the tools to accommodate users of different ages and abilities; thereby improving the educational approach.

The app called **Hahai** that has been developed and tested is a perfect example that meets this need. The application has become a real scholastic project; it can integrate digital devices into the normal educational approach.

Related work is described in the paper according to the following scheme:

- Section 2: How the problem is experienced by society, the life skills of new generations and innovative solutions;
- Section 3: The design of the Hahai project and the app development;
- Section 4: The testing carried out at the Giovanni Cena primary school of Perugia, Italy and the final report that includes statistics and views;
- Section 5: Conclusions and future developments.

2 Global Society and Technology

2.1 Life Skills

The development of technologies in all areas of society cannot be ignored. In fact, some research estimates that by 2026, 90% of the population will have a device connected to the Internet, including children. Many studies showed how digital devices integrated into everyday life, so the *Department of Mental Health of the World Health Organization* has drawn up a list of skills needed for life, called *Life skills*.

They can be summarized in seven competencies:

- critical and analytical thinking;
- creative and alternative thinking;
- cooperation;
- intercultural relations;
- effective communication;
- digital skills;
- self-awareness or initiative.

To let the digital devices have a positive impact on the digital natives' approach to the future, it is necessary to spread a digital education that makes them aware of the dangers of the Internet: cyberbullying, explicit material, data theft.

Responsibility and Education of Society. In the Digital Age, schools cannot ignore digital change; they must control and promote it in the right direction. School is the biggest promoter of innovation, and therefore also of digital content, and it is with this in mind that in recent years *National Plans* have been promulgated to promote the development of digital skills in students of all ages, aware that school activities cannot exclude the use of technology.

Defining the student required skills is difficult. First of all, the needs of the twenty-first century, which include new knowledge and skills, have to be satisfied. Schools must try to introduce logical and *computational thinking* and then allow students to learn modern technologies.

The *World Economic Forum* realized research [3] and determined that the *digital skills* on which world education must invest resources are eight:

- *Digital Identity*: Awareness of your online presence and guaranteeing your online reputation.
- *Digital Use*: The ability to use different devices and systems.
- *Digital Safety*: It is necessary to recognize and avoid the risks associated with the use of digital technologies.
- *Digital Security*: Learn how to protect personal data and devices appropriately and achieve the ability to predict and recognize the dangers of hacking, scams, or malware.
- *Digital Emotional Intelligence*: Understanding and knowing how to approach to communicate with others through a device.
- *Digital Communication*: The ability to communicate and collaborate through the use of digital devices and media.
- *Digital Literacy*: Learn how to research and share data, considering the source and testing credibility.
- *Digital Rights*: Know the rights of freedom of expression, privacy and the intellectual property of one's own creations.

Unfortunately, adults are *"digital immigrants"* and they are not always able to support digital natives in the careful access of digital systems. For this reason, many educational organizations have started special courses. These courses teach the new generation to use digital devices.

2.2 Computational Thinking

Computational thinking [4] is a skill often associated with the figure of the computer scientist because of its ability to be able to break up big problems into small problems connected between them. This is a skill that everyone has, and it is considered as the *fourth basic skill* besides reading, writing, and mathematics. When human beings are solving problems, designing systems, or following any

other behavior based on the concepts used in computer science, we are referring to computational thinking.

Computational thinking improves a child's analytical skills. This ability allows you to find an algorithmic procedure that grants to solve a hard problem through the decomposition and reduction of the problem in smaller sections. Computational thinking is not necessarily related to computer and mathematical fields, but it is a way of thinking to deal with everyday life, study, or work.

The global society needs to have citizens who make their own choices with critical thinking. The new generation will need to be able to identify problem-solving methods. Digital skills can improve this learning process because they are based on two fundamental scenarios: *problem-solving* and *creative approach.*

Problem-Solving. In this scenario, the student has to solve logic problems of increasing difficulty. Computational thinking will be introduced gradually. In the beginning, it starts with a few instructions and then increases the difficulties. The child will need new ways of thinking. Visual programming blocks (coding at school [5]) is the most used model in schools.

Creative Approach. This scenario focuses on creativity: students implement a project without receiving specific input. In this way, students will face computational thinking concepts and they will be more interested in learning how to carry out their projects. The learning process will be less structured: it will happen by trial and error and free associations.

2.3 Solution: Hahai Project

Hahai is developed for children who are learning to read and write. This project combines the concepts of problem-solving and creative approach, also introduces digital devices in the learning process. The children play, have fun and learn by creating stories, and they can do this in collective or in small groups. Digital storytelling is an excellent solution that can be used in this age group and **Hahai** is suitable for its ease of use.

3 The Hahai Project and Development

3.1 Requirements Analysis

First development phase: A brainstorming session was carried out with the teachers of the *Giovanni Cena* primary school (*Perugia, Italy*). In this phase, the requirements analysis was written and **Hahai** was designed. It has designated goals and functions: the focus of the app is *digital storytelling.*

Hahai allows you to create digital stories about *literature* and *mathematics. "Storytelling activity"* is a different activity, and it tells these stories. The stories comprise a sequence of images and sounds made with children's drawings and voices [6–8]. In the *Letters* topic, it is possible to create new topics other subjects (e.g. *religion*, *foreign languages*).

3.2 Wireframe and Graphic Design

After performing the requirements analysis, the application's *navigation map* was designed (*wireframe project*, Fig. 1) to summarize its composition.

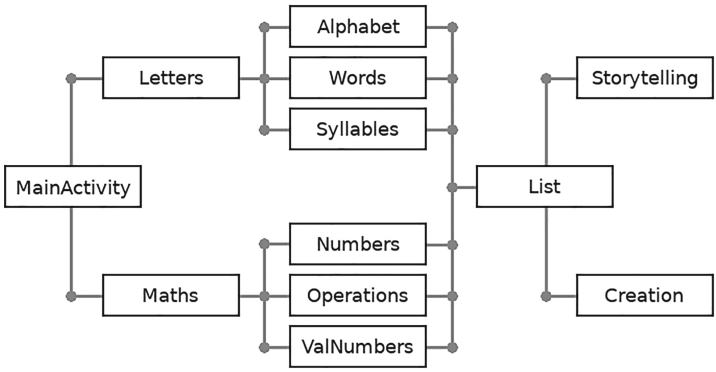


Fig. 1. *Hahai navigation map*

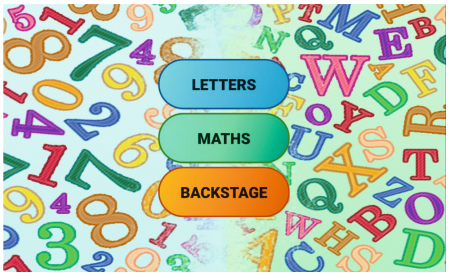
The activities link to each other in the same way you visit the app. The secondary functions required by the app were written next to the wireframe project. Once the wireframe project was approved, the code development was the next phase.

Activities Design. Hahai is developed in *Kotlin programming language* and this app is multilingual: currently, the languages available are English, Italian, and Spanish. **Hahai** recognizes the language set on the device and translates all activities content and views. In the future, with a patch, other foreign languages will be added simply by updating the *translation table*.

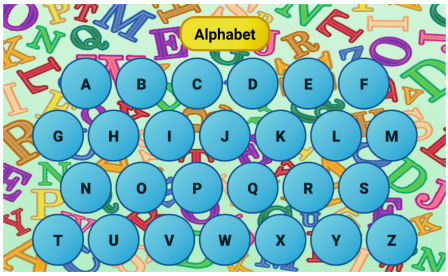
The following figures show some layouts of the app (Figs. 2 and 3).

The hardest class to create was *Creation activity* (Fig. 3, a) since it was necessary to manage each task. In the *Creation layout*, the *"Add Drawing"* and *"Add Audio"* buttons show a pop-up where the user can add the file: images and sounds can be *picked* from the storage or *captured* on the spot. A compressed copy will be added to the internal storage, and its *URI* will be stored in an array. This array will be saved in the database when finished creating the story. The bottom buttons manage the narration scenes, and the left views are a preview of the scenes.

The *Storytelling activity* (Fig. 3, b) finds the story in the database and creates arrays of images and sounds. The *ImagePagerAdapter* view will show the images, while the buttons will start/stop the sounds.



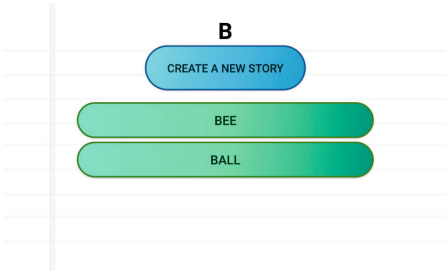
(a) *MainActivity Layout*



(b) *Alphabet Layout*

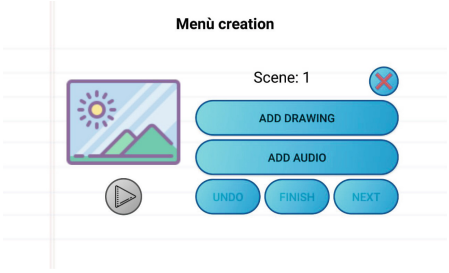


(c) *Words Layout*



(d) *List Layout*

Fig. 2. *Hahai user interface*



(a) *Creation Layout*



(b) *Storytelling Layout*

Fig. 3. *Creation and Storytelling activities*

4 Testing Phase

4.1 Official Testing in First-Grade Classes

The app was tested on a group of first-grade elementary students composed of 31 children. The testing was carried out in the first month of school, in September and October. Hahai would have improved reading, writing, and mathematics by creating digitized stories as if it were a new game.

Motivations of the Test. As already written, the development of technologies changed people's lives, and in particular that of the new generation. This test aims to integrate digital devices in the school environment to teach children the importance of technological tools.

Test Methods. Starting from the topic, the children invented the story. They chose the characters and the setting of the story. The teacher wrote the story in a notebook and drew a preview of each scene on the blackboard. The children in groups drew the scenes on paper. Once that is done, the students recorded the lines, and the teacher prepared the digital material to build the story on **Hahai**. Everyone worked together to build the story through the interactive multimedia whiteboard. Digital storytelling caught everyone's attention, and the children enjoyed commenting on the quality of the story. Vote chose the title of the story.

Children are intrigued by digital technology. In this regard, **Hahai** shows the potential of using digital devices in teaching methods. Digital natives are familiar with the use of digital devices, but using them in class to teach lessons is new.

In this lesson, the children gained the approach to computational thinking. They have learned to analyze the problem and find the algorithmic procedure to solve it. The students collaborated and realized something creative and instructive. They respected each other's opinions and showed a spirit of initiative.

4.2 Final Report

The teachers gave their views about testing before getting statistics from children. The focus group showed that it is important to introduce digital technologies in schools. The teachers said that the new generations will need to know how to use fully digital technologies. To achieve this goal, it is good to start with the first-grades of primary school. **Hahai** offers easy-to-use digital storytelling, both for teachers and children. Learning from very young people to handle these devices will allow the new generation to be more skilled. Digital devices are an enhancement of the teaching methods and increase children's open-mindedness.

In the last testing phase, the children filled out a questionnaire related to these special lessons. This activity showed the abilities of children to reconstruct the stages to invent a story. The final part of the form required students' opinions and gave a vote to the experience. This questionnaire has become a great tool from which to get statistics.

Statistics. The questionnaire comprised seven questions of varying complexity. The first question required the stages to invent a story with **Hahai** (Fig. 4). Half of the children correctly showed the logical sequences, but the difficulty of connecting seven phases emerged. The children reacted by focusing on the details for them more operative and engaging, ignoring aspects in which the adult did the work.

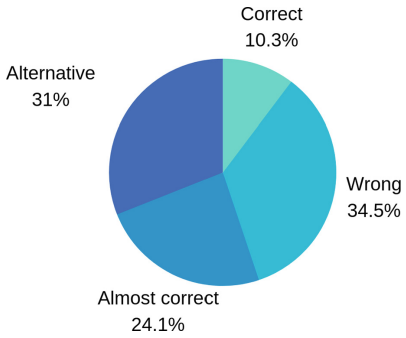
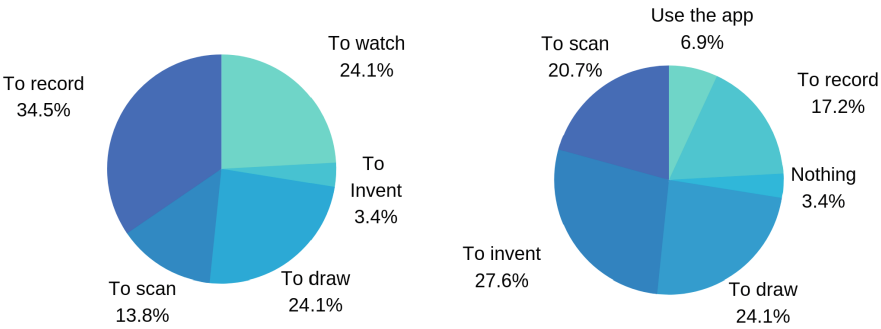


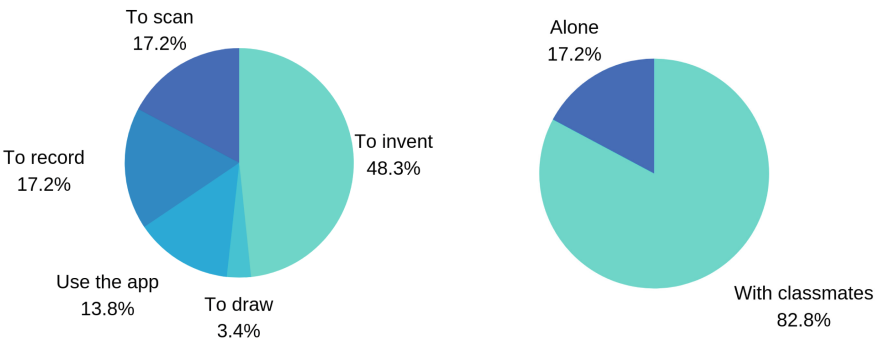
Fig. 4. Correct sequence of progress chart

The other questions required responding with the favorite stage, with the most difficult stage and the most boring stage (Figs. 5 and 6).



(a) *Most favorite stages chart* (b) *Most boring stage chart*

Fig. 5. Questionnaire results



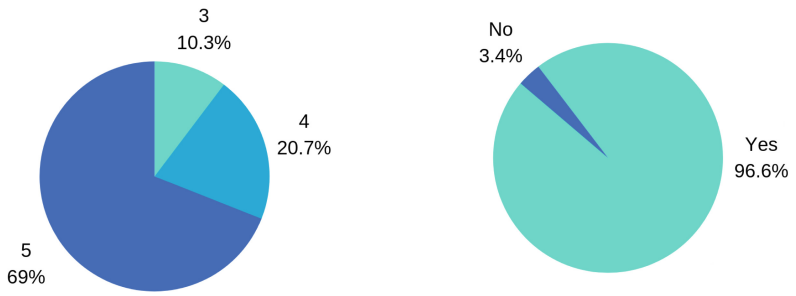
(a) *Most difficult stages chart* (b) *Collaboration chart*

Fig. 6. Questionnaire results

The stages where the children were most involved turned out to be the favorites.

The answers to the most boring stages were those that occur every day: inventing, drawing. The fact of building the story together has created difficulties: the children will gain group collaboration over time.

In conclusion, the results of the tests ran in the primary school show that the experience was particularly constructive (Fig. 7); the activity of storytelling was positive and pleasant.



(a) *Appreciation level chart* (b) *Repeat experience chart*

Fig. 7. Results of the questionnaire

5 Conclusions and Future Developments

5.1 Conclusions

The digital revolution and the use of the Internet have become an integral part of people's lives. As a consequence, the population is affected by a sudden change, which brings to instability and uncertainty because of the fear of changing the everyday routine. Continuous adjustment to new technologies can be positive once people become aware of the changes.

Nowadays revolutions such as the "digital and technological revolution", the globalization, the socio-economic, the cultural and the migratory, influence the society. Individuals can react and handle the above-mentioned revolutions and changes being conscious, mentally flexible, and hence avoid exclusion.

The school system and the family have a major role and the responsibility to educate and guide the new generation, so-called "digital natives", to familiarize with technology in the scholastic environment and use it constructively. As already mentioned, digital natives are born with the ability to use technological devices, although they have to be taught how to do it positively and effectively. It is the duty of competent adults to intervene and neutralize what could become the problem of the third millennium.

Technology and digital literacy are slowly spreading in the scholastic environment, thus the **Hahai** application is an appropriate tool to introduce in schools. The children were enthusiastic and effectively learned in a playful and functional way.

Teachers involved stated their satisfaction towards the effectiveness of the app to improve the strategies of reading, writing, and mathematics.

5.2 Future Developments

Computer scientists have played a major role in developing products on commission; given that it is a different task to implement an application for a specific target audience, such as children and young adults, during their learning journey to become adults. The use of this tool in a single school would be inconvenient. Educational establishments should have the aim of sharing positive online innovative strategies, both technological and disciplinary.

It is presumptuous to consider the app completed; it would be effective to share it online to improve its growth and receive feedback. By setting up an online server, the stories will be uploaded to an online database and can be viewed by any device that uses it. This update would create a global comparison network [9–13,20].

An app for education is successful if the family uses it in their spare time. In this way, it can become an effective tool for playing with parents who could easily see the stories made by their child.

An interesting and useful addition could be the creation of a website with the same features of the application, in order to make it accessible to different devices and not restricted exclusively to Android devices [14–19].

5.3 Technology as a Tool for Training

The results of this research highlightwhat could prevent the development and diffusion of technologies within the school system. The percentage of teachers willing to use digital devices as teaching tools is very low: 10% of the teachers try to use these devices, an additional 10/15% use them to show films, download course material or as a recreational tool, and the remaining 75/80% does not use them. The low usage of digital devices by teachers could be justified as a lack of knowledge and awareness on the subject. Therefore, they often can not use digital devices; hence, they would find it difficult to change their teaching methods. It could be recommended to act in this matter and offer compulsory training courses for teachers to update them continuously on the development of digital devices.

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