LEGO-KINTSUGI: A NEW TEACHING AND EDUCATIONAL METHODOLOGY TO ENHANCE LIFE SKILLS AND DIGITAL LIFE SKILLS, CREATE WELL-BEING AND EDUCATE HAPPINESS

LEGO-KINTSUGI: UNA NUOVA METODOLOGIA DIDATTICO-EDUCATIVA PER VALORIZZARE LE LIFE SKILLS E LE DIGITAL LIFE SKILLS, CREARE BENESSERE ED EDUCARE ALLA FELICITA'

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ABSTRACT
Lego-Kintsugi is an innovative teaching methodology able to combine LEGO® Education Robotics teaching with the Japanese practice of *Kintsugi*. It integrates emotional intelligence with the skills required for the development of artificial intelligence systems and can represent a new way of "doing teaching" aimed at overcoming fragility and healing small "daily cracks" through storytelling and emotional meta-reflection and, enhancing *life skills* and *digital life skills*, creating well-being and promoting happiness at school.

Il *Lego-Kintsugi* è una metodologia didattica innovativa in grado di combinare l'insegnamento della Robotica LEGO® Education con la pratica giapponese del *Kintsugi.* Integra l'intelligenza emotiva con le competenze richieste per lo sviluppo di sistemi di intelligenza artificiale e può rappresentare un nuovo modo di "fare didattica" volto a superare fragilità e sanare piccole "crepe quotidiane" attraverso lo storytelling e la metariflessione emotiva e, valorizzando *life skills* e *digital life skills*, creando ben-essere e promuovendo felicità a scuola.

KEYWORDS
LEGO Robotics; digital life skills; artificial and emotional intelligence; well-being at school.
Robotica LEGO; competenze digitali; intelligenza artificiale ed emotiva; ben-*essere* a scuola.

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Introduction

In today's society, characterized by multiple changes and discontinuities, the educational landscape has become extremely complex and the historical-social scenario is increasingly permeated by emotional and relational lability.

The School, therefore, is called to face the educational emergency generated by the repercussions of such a fragile context and to seek new educational strategies to encourage children, adolescents and young people to heal the "*cracks*" that this situation has created in the personal process of psycho-emotional development, promoting the condition of well-being at school and educating happiness.

The diffusion of information and communication technologies, therefore, becomes a great opportunity for the School to relate the complexity of radically new ways of learning and to create environments conducive to the development of life skills and new digital life skills.

To do this, the School is called to carefully read the needs of young students and to enhance different talents through methodological and innovative choices increasingly in line with the needs of young students.

This study, therefore, aims to combine the didactic action of the LEGO® Education SPIKE™ Prime program and the "secret art of repairing life" of *Kintsugi*, to investigate how a "new teaching methodology" of STEAM disciplines can integrate emotional intelligence with the skills required for the development of artificial intelligence systems with a view to promoting life skills and new digital soft skills in a school environment imbued with well-being and happiness.

1. LEGO® Robotics and Education.

LEGO® has a long and impressive history as an effective educational tool for all ages (Irgen-Gioro, 2016; Souza et al. 2018). Several educators adopt LEGO® to teach maths, computer science, and engineering in different levels including educational therapy for children with autism and disabilities (Cliburn, 2016; Disseler & Mirand, 2017; Altakhayneh, 2020; Levy & Dunsmuir, 2020).

LEGO® Education has worked with education specialists for around 40 years, with the aim of generating diverse learning experiences that entertain and impact students. They have a wide variety of practical and digital educational resources that promote students to change the way they think, focusing on creativity and systematic reasoning.

Today all the tools that present themselves to STEAM literacy (acronym for Science, Technology, Engineering, Art and Mathematics) and which involve all

levels of education, from kindergarten to high school, are based on playful learning. There are many varied and diversified combinations of digital resources and curricula that act as useful tools for stimulating, attractive and effective learning.

LEGO® Education SPIKE™, in the *Essential* and *Prime* versions, allows, thanks to the use of easy-to-use hardware, intuitive programming based on a language that has the use of Scratch as its background and which proposes activities that lead to critical thinking and to enhance the ability to solve complex problems by helping students learn essential STEAM skills necessary for the evolution of innovative minds (Tavera, 2022).

LEGO® Education SPIKE™ Essential stimulates primary school students' interest in learning STEAM subjects through play, problem solving and storytelling, preparing them to develop a resilient and independent mindset.

LEGO® Education SPIKE™ Prime, instead, is a solution that combines practical construction and digital programming. It is designed to simplify the teaching of STEAM subjects in middle and high schools, and is able to arouse so much interest in students that they can look forward to participating in subsequent lessons.

The Spike Prime kit contains more than 500 LEGO® bricks and a pack of important additional elements to replace those that are lost during lessons.

Programmable hardware elements include two medium motors, a large motor, a color sensor, a force and pressure sensor, a distance sensor, and a six-port hub with an integrated six-axis gyro sensor.

The six-port Prime hub features a rechargeable battery and Bluetooth connectivity. The SPIKE™ app offers students a solid foundation for learning STEAM subjects, facilitating the acquisition of new skills. Pupils use Scratch-based programming blocks in a simple and intuitive environment where to test themselves with what is proposed by the different lesson plans. The educational plan and programming method is designed to allow anyone to try their hand at building and programming robotic prototypes, even if they do not have basic digital skills and coding experience.

Each lesson included in the LEGO® Education SPIKE™ Prime lesson plan involves the use of the SPIKE™ app. This application eliminates worksheets and offers students immediate, simple and intuitive access to viewing the materials and the lessons dedicated to them. All lesson plans are aligned to the school curriculum and make STEAM subjects simple, fun, interesting and above all accessible to all pupils, especially those with special educational needs. Almost all lesson plans are designed to be done in 45-minute sessions, and all include a construction portion and a programming portion.

To access the lesson plans, simply access the dedicated LEGO® platform[2], filter by product, age group or topic, or perform a keyword search to find the desired topic based on different teaching needs.

LEGO® Education SPIKE™ Prime includes 8 learning units for a total of 45 lessons. Each unit has a unique learning objective that summarizes everything students will learn throughout the entire unit. Each learning unit consists of a progression of individual lessons aligned to standards and focused on STEAM disciplines. It would be desirable to carry out the lessons in sequential order because each lesson allows students to acquire new skills and greater confidence, thus anchoring new knowledge to that already possessed and encouraging significant learning.

Each lesson plan provides teachers with detailed instructions for carrying out lessons in the classroom, reporting specific learning objectives, expected learning outcomes and training standards. Since all lessons are in line with the school curriculum, they can be easily integrated into ordinary curricular lessons or included in extracurricular projects specifically designed to broaden the curriculum of the training offer and to enhance the talents of students.

Furthermore, the lesson plans are designed to specifically encourage the strengthening of digital life skills, and this is easily deduced from the detailed analysis of the Computing Progression Pathways described within the Educational Standards required by the individual lessons. In fact, the progression of the lessons leads students to design, write and debug modular programs using procedures, to know that computers collect data from various input devices, including sensors and application software, to use criteria to evaluate the quality of solutions, can identify improvements making some refinements to the solution, and future solutions, to designs criteria to critically evaluate the quality of solutions, to use the criteria to identify improvements and can make appropriate refinements to the solution, as well as recognizing the different solutions and the same algorithms that can be used to solve the same problem.

It is of particular importance to draw attention to the fact that the valorisation and strengthening of such specific and complex digital skills can be considered basic skills for the development of those skills necessary for the development of artificial intelligence systems.

In fact, several researchers have combined the use of LEGO® in teaching processes with the development of skills necessary for the implementation of systems based on artificial intelligence (Klassner, 2022; Talaga & Oh, 2009; Irgen-

[2] https://www.legoeducation.com/lessons

Gioro, 2016). Therefore, developing projects in schools based on the study of STEAM disciplines with the use of LEGO® could appear as a suitable path for strengthening the new digital soft skills envisaged by the Digicomp 2.2 program (Vuorikari et al., 2022), and therefore encouraging the development of preparatory skills for the effective use of the new systems of artificial intelligence.

2. *Kintsugi* and Education

Kintsugi is an ancient technique, developed in Japan in the fifteenth century. It is a real art that consists of repairing a broken object with gold. In this way the cracks are highlighted and not hidden. This is the basis of the profound philosophy of *Kintsugi* which goes far beyond simple artistic practice. In fact this symbolism speaks of healing and resilience. Carefully repairing an object is nothing more than a metaphor that highlights the importance of knowing how to accept, and above all recognize, one's past, any traumatic events, the small and large daily cracks that can be created within life of each one.

An object repaired with gold becomes more precious, more beautiful and therefore the effective overcoming of an emotional wound allows those who have succeeded in this path to become stronger, equipped with new light, thanks to this important healing process.

The Japanese term *kintsugi* is made up of two words: *kin*, meaning “gold” and *tsugi*, meaning “repair”. The art of *kintsugi* is called *kintsukuroi*, which means "repairing with gold" (Navarro, 2018).

The post-pandemic scenario outlines a highly unstable society characterized by profound liquidity and instability. The same instability that characterizes the adolescent and pre-adolescent period that young students experience in their natural growth process.

The fragility that emerges in this context is closely linked to the concepts of "vulnerability" and "loss of adaptive capacity" (Kinchin & Winstone 2017), with the real risk of offering institutional teaching approaches lacking "resilience to face change" (Olivieri & Cardinali, 2021).

In a context characterized by so many changes and full of fragility, today's student must be accompanied to build a solid personal identity capable of structuring the citizen of tomorrow, able to orient himself in broad contexts, which go beyond the territory national.

To do this, each student must acquire useful skills in order to orient themselves constructively in a world that is experiencing constant changes.

The school, therefore, plays a crucial role in the education of new generations of students and must act as a guide attentive to the needs of individuals.

Learning to understand the reality in which we live becomes an essential prerogative for today's teacher to structure teaching programs and learning environments such as to be able to place the student at the center of a teaching-learning process that aims at mature growth oriented towards decisive choices and increasingly aware. The school is called to encourage the creation of learning environments based on the well-being of the individual, capable of offering the possibility of structuring increasingly strong and clear-cut identities and offering effective and immediate responses to risk and disaster situations (Olivieri and Cardinali, 2021).

Based on all this, the ancient Japanese art of *Kintsugi* can be considered a valid metaphor for an idea of resilience necessary to cope with all this instability and can be understood as a didactic challenge to give life to emotional learning capable of live every experience of daily life with positivity, even the most painful ones (Santini, 2018; Santini, 2019; Harris et al., 2022).

This transformative and sustainable pedagogy, inserted in the school context, can become a harbinger of well-being by educating happiness, as a skill to be built daily (Dato et al., 2021; Bevilacqua & Filippone, 2023). And a school that bases its teaching on well-being and education for happiness is a sustainable and resilient school.

3. Lego-*Kintsugi*: a new methodological proposal to promote well-being and developing life and digital skills

Just as a broken object can be repaired with gold so as to give it new life, new light, new meaning, even an object built with LEGO® bricks can break and be rebuilt using new bricks, new colors in a transformative frame that can bring to the creation of an object made new by the changes adopted. In the same way, digital programming can also be remodulated by inserting blocks that improve its performance.

It is on the basis of this parallelism, and in light of what has been discussed so far, that a new methodological proposal aimed at combining Lego Education Robotics teaching with the Japanese practice of *Kintsugi* was born at the Comprehensive Institute Foscolo-Gabelli in Foggia (Italy).

This new methodological approach integrates emotional intelligence with the skills required for the development of artificial intelligence systems and can represent a new way of "doing teaching" aimed at overcoming fragility and healing small "daily cracks" through storytelling and emotional meta-reflection and, enhancing life skills and digital life skills.

After having carried out a lesson prepared by the LEGO® Educational Spike Prime educational plan, and therefore having built a robot with LEGO® bricks, programming it with the programming blocks as provided by the SPIKE™ app, the students are asked to identify in the work carried out, both in construction and programming, limitations and weaknesses.

In this way they will be able to choose the optimal strategies to dismantle (and therefore "break") and reconstruct (and therefore "repair" and "give new life") a new prototype equipped with structural and programming characteristics (also "rebuilt" and therefore equipped with "new life") such as to favor a better performance that is more responsive to the objective pre-established at the start.

Lego-*Kintsugi* methodology, therefore, consists in following this teaching activity with a moment of personal reflection in which to associate the LEGO® prototype with a situation linked to the students' daily lives in order to be able to analyze their weaknesses and critical points and be able to accept the "fracture" and "rebuild" (and "reconstruct yourself") by accepting the wounds suffered without shame, accepting the mistakes made in the situation experienced, learning to face traumatic events in a positive way and to grow through painful experiences, thus living this experience as emotional learning in itself (Olivieri & Cardinali, 2021).

The experimentation was conducted in the middle school of a Comprehensive Institute, a DADA school, whose teaching action is based on the Teaching Methodology for Learning Environments (Fattorini, 2022), and which conducts a path with the University of Foggia and the Pegaso University of valorization of talents with a view to scholastic well-being and the development and enhancement of life skills and digital soft skills.

3.1. Material and Methods

A heterogeneous sample of 120 pupils (40 attending the first class, 40 the second class and 40 the third class), who chose to voluntarily join a project (from September 2023 to February 2024) for the valorization of talents, participated in the experiment. Pupils with Special Educational Needs were present.

The composition of the sample is reported in detail in Table 1.

	1st year	**2nd year**	**3rd year**
total students	**40**	**40**	**40**
male	28	26	30
famale	12	14	10
total SEN* students	**9**	**11**	**10**
D Students*	4	5	5

SLD Students***	5	6	5

*Students with Special Educational Needs
**Students with Disability
***Students with Specific Learning Disorders

Table 1: *Sample composition.*

The training activity of the experimental project was structured according to a work protocol which involved the creation of 8 robotic prototypes as reported in the relevant 8 lesson plans chosen for the experimentation and foreseen by the LEGO® Education SPIKE™ Prime program, created initially according to the methods of standard construction and programming and reworked in a personalized form following a reflection characterized by the *Kintsugi* method.

Table 2 shows the lesson plans chosen for the experimentation, the related learning units foreseen by LEGO® Education SPIKE™ Prime program, the main learning objectives and the educational standards standards referring to the school subjects involved in the lesson plans.

Lesson 1	**Learning Unit**	**Learning Objectives**
Help!	Invention Squad	*-Define a problem.* *-Begin to establish criteria that will eventually lead to a solution.*
Educational Standards		
School Subjects	***Learning indicators***	***Skill Descriptors***
Maths	Space and figures	*Visualize three-dimensional objects from two-dimensional representations.*
Technology	See, observe, experience	*Approach new IT applications by exploring their functions and potential.*
	Intervene, transform and produce	*-Disassemble and reassemble simple objects.* *-Program computer environments and develop simple instructions to control the behavior of a robot.*
	Predict, imagine and plan	*Evaluate the consequences of choices and decisions relating to problematic situations.*
Language (Italian)	Listening and Speaking	*-Intervene in a conversation or discussion, in class or in a group, with relevance and coherence, respecting speaking times and turns and providing a positive personal contribution.* *-Report orally on a topic of study, explaining the purpose and presenting it clearly.*
	Writing	*-Write expository texts.* *-Writing digital texts, also as a support for oral presentation.*
Lesson 2	**Learning Unit**	**Learning Objectives**
Hopper Race	Invention Squad	*Explore the process of creating prototypes to solve a problem.*
Educational Standards		
School Subjects	***Learning indicators***	***Skill Descriptors***

Maths	Space and figures	*Visualize three-dimensional objects from two-dimensional representations.*
Technology	See, observe, experience	*Approach new IT applications by exploring their functions and potential.*
	Intervene, transform and produce	*-Disassemble and reassemble simple objects.* *-Program computer environments and develop simple instructions to control the behavior of a robot.*
	Predict, imagine and plan	*Estimate physical quantities.*
Language (Italian)	Listening and Speaking	*Report orally on a topic of study, explaining the purpose and presenting it clearly.*
	Reading	*Obtain explicit and implicit information from expository texts, to obtain information on a specific topic or to achieve practical purposes.*
	Writing	*-Write expository texts.* *-Writing digital texts, also as a support for oral presentation.*
Lesson 3	**Learning Unit**	**Learning Objectives**
Super Clean Up	Invention Squad	*-Define evaluation criteria for two designs.* *-Test two designs using objects of different shapes and sizes.* *-Make recommendations regarding the best design.*
Educational Standards		
School Subjects	***Learning indicators***	***Skill Descriptors***
Maths	Numbers	*-Understand the meaning of percentage and know how to calculate it using different strategies.* *-Interpret a percentage change in a given quantity as a multiplication by a decimal number.*
	Space and figures	*Visualize three-dimensional objects from two-dimensional representations.*
Technology	See, observe, experience	*Approach new IT applications by exploring their functions and potential.*
	Intervene, transform and produce	*-Disassemble and reassemble simple objects.* *-Program computer environments and develop simple instructions to control the behavior of a robot.*
	Predict, imagine and plan	*Imagining changes to everyday objects and products in relation to new needs or requirements.*
Language (Italian)	Writing	*Writing digital texts, also as a support for oral presentation.*
Lesson 4	**Learning Unit**	**Learning Objectives**
Pass the Brick	Supplementary Lessons	*Demonstrate the ability to work effectively and respectfully with different types of people.*
Educational Standards		
School Subjects	***Learning indicators***	***Skill Descriptors***

Maths	Data and forecasts	*Represent sets of data (…) compare data in order to make decisions, using frequency distributions and relative frequencies.*
	Space and figures	*Visualize three-dimensional objects from two-dimensional representations.*
Technology	See, observe, experience	*Approach new IT applications by exploring their functions and potential.*
	Intervene, transform and produce	*-Disassemble and reassemble simple objects.* *-Program computer environments and develop simple instructions to control the behavior of a robot.*
	Predict, imagine and plan	*-Imagining changes to everyday objects and products in relation to new needs or requirements.* *-Plan the different phases for creating an object using everyday materials.*
Language (Italian)	Listening and Speaking	*Intervene in a conversation or discussion, in class or in a group, with relevance and coherence, respecting speaking times and turns and providing a positive personal contribution.*
Physical Education	Game, Sport, Rules, Fair Play	*Create game strategies, implement collaborative behaviors and participate proactively in the team's choices.*
Lesson 5	**Learning Unit**	**Learning Objectives**
Keep It Safe	Kickstart a Business	*-Explore conditional programming.* *-Be able to explain the principles of digital security.*
Educational Standards		
School Subjects	***Learning indicators***	***Skill Descriptors***
Maths	Space and figures	*Visualize three-dimensional objects from two-dimensional representations.*
Technology	See, observe, experience	*Approach new IT applications by exploring their functions and potential.*
	Intervene, transform and produce	*-Disassemble and reassemble simple objects.* *-Program computer environments and develop simple instructions to control the behavior of a robot.*
Lesson 6	**Learning Unit**	**Learning Objectives**
Automate it!	Kickstart a Business	*Use computational thinking skills to produce a complete solution to a problem.*
Educational Standards		
School Subjects	***Learning indicators***	***Skill Descriptors***
Maths	Space and figures	*Visualize three-dimensional objects from two-dimensional representations.*
Technology	See, observe, experience	*Approach new IT applications by exploring their functions and potential.*
	Intervene, transform and produce	*-Disassemble and reassemble simple objects.* *-Program computer environments and develop simple instructions to control the behavior of a robot.*

	Predict, imagine and plan	*Imagining changes to everyday objects and products in relation to new needs or requirements.*
Language (Italian)	Writing	*-Know and apply the procedures for conceiving, planning, drafting and revising the text starting from the analysis of the writing task: use tools for organizing ideas (e.g. maps, ladders); use tools for text revision; respect graphic conventions.* *-Writing digital texts, also as a support for oral presentation.*
Lesson 7	**Learning Unit**	**Learning Objectives**
Break Dance	Life Hacks	*Effectively use different data types such as time (seconds), speed and degree of rotation.*
Educational Standards		
School Subjects	***Learning indicators***	***Skill Descriptors***
Maths	Numbers	*-Perform operations with fractions, space and figures.* *-Visualize three-dimensional objects from two-dimensional representations.*
Technology	See, observe, experience	*Approach new IT applications by exploring their functions and potential.*
	Intervene, transform and produce	*-Disassemble and reassemble simple objects.* *-Program computer environments and develop simple instructions to control the behavior of a robot.*
Language (Italian)	Listening and Speaking	*-Intervene in a conversation or discussion, in class or in a group, with relevance and coherence, respecting speaking times and turns and providing a positive personal contribution.* *-Report orally on a topic of study, explaining the purpose and presenting it clearly.*
	Reading	*Obtain explicit and implicit information from expository texts, to obtain information on a specific topic or to achieve practical purposes.*
Physical Education	Health and well-being, prevention and safety	*Practice movement activities to improve your physical efficiency, recognizing their benefits.*
Lesson 8	**Learning Unit**	**Learning Objectives**
Veggie Love	Life Hacks	*Calibrate a scale to display accurate data in a useful and reliable way.*
Educational Standards		
School Subjects	***Learning indicators***	***Skill Descriptors***
Maths	Numbers	*-Use the concept of ratios between numbers or measures.* *-Use graduated scales in contexts relevant to science and technology.*
	Space and figures	*Visualize three-dimensional objects from two-dimensional representations.*
	Data and forecasts	*Represent data sets.*
Technology	See, observe, experience	*Take measurements.*

		-Approach new IT applications by exploring their functions and potential.
	Intervene, transform and produce	*-Disassemble and reassemble simple objects.* *-Program computer environments and develop simple instructions to control the behavior of a robot.*
	Predict, imagine and plan	*Imagining changes to everyday objects and products in relation to new needs or requirements.*
Language (Italian)	Listening and Speaking	*Listen to texts by applying techniques to support comprehension: during listening (taking notes, key words, short summary sentences, conventional signs) and after listening (reworking of notes, clarifying key words, etc.).*
Science	See, observe, experience	*Use fundamental physical concepts (e.g. temperature) in various experiential situations.*

Table 2: *Lesson Plans by LEGO SPIKE Prime educational Program*[3]

Each lesson was divided into three phases. In the first phase, the students first followed the instructions to build and assemble the robotic prototype and subsequently reproduced a pre-set block programming scheme from the SPIKE ™ application, so as to allow the robot to function. In the second phase, however, guided by the tutor teachers, they identified the structural and programming problems that did not allow the robot to function effectively.

Therefore, they deployed their digital skills and divergent thinking to remodulate the robotic prototype both in its structural conformation and in its design, to promote optimal or at least more effective performance. In the third and final phase all the students, also in this case under the guidance of the tutor teachers, applied the Kintsugi metaphor to a problematic personal situation, as previously stated, giving rise first to a personal reflection and then to sharing in groups organized by the tutor teachers. The moment of reflection was structured as follows: i) a brainstorming phase in which each student shared their thoughts immediately and without the possibility of structuring specific strategies for the presentation of one's own experience; ii) a phase of sharing the personal episode chosen through the creation of a digital product that represents what was exposed; iii) a phase of restitution of the emotions felt by listening to shared experiences through the choice and subsequent sharing of an image within a digital photo album or creating a digital storytelling (Carruba, 2015).

[3] https://education.lego.com/it-it/lessons/?products=Set+SPIKE%E2%84%A2+Prime

The 5 skills described by the Digicomp 2.2 plan were assessed upon entry and exit together with the 10 life skills as identified by the WHO (1996) using observation grids by the tutor teachers.

Figure 1 reports the conceptual reference model of DigComp in which the 21 competences (dimension 2) are grouped into the five competence areas (dimension one).

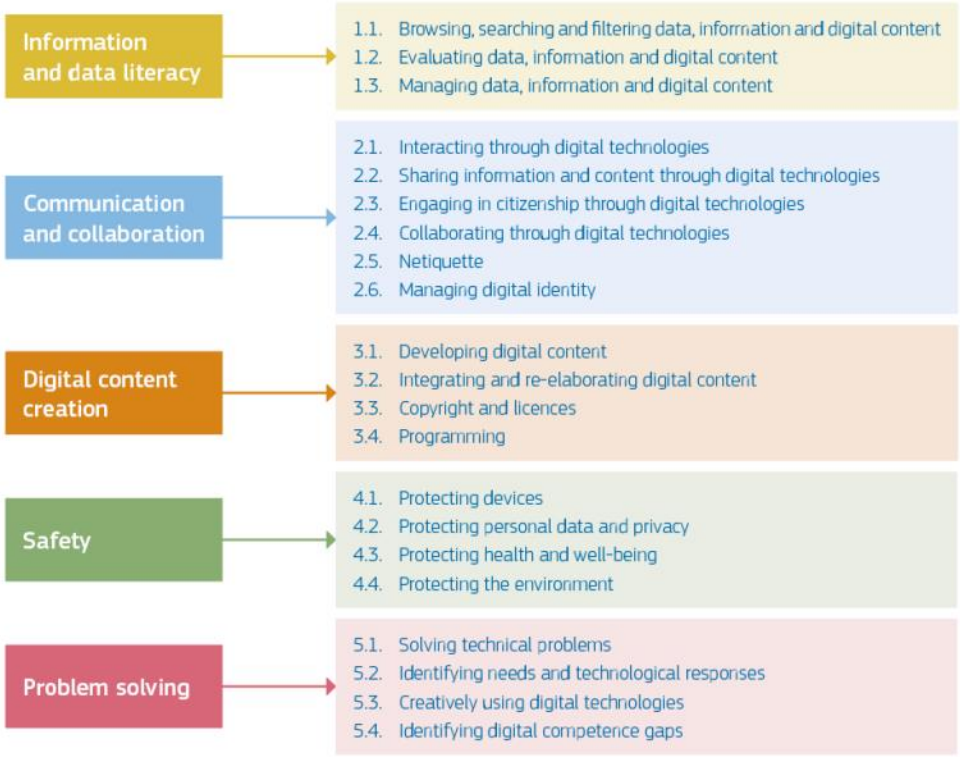


Figure 1: *The DigComp conceptual reference model (Vuorikari et al., 2022).*

In this experiment, for each student, each of the 21 skills were evaluated using a graduated observation grid with a score from 1 to 10, which represented in quantitative terms the value expressed by the tutor teachers, using the learning scenario as a descriptor (dimension 5) which depicts the link between the use case and its proficiency level (Vuorikari et al., 2022).

Figure 2 shows the 10 life skills recommended by the World Health Organization which were also evaluated using a graduated observation grid with a

score from 1 to 10, which also in this case represented the value expressed by the tutor teachers in terms quantities.

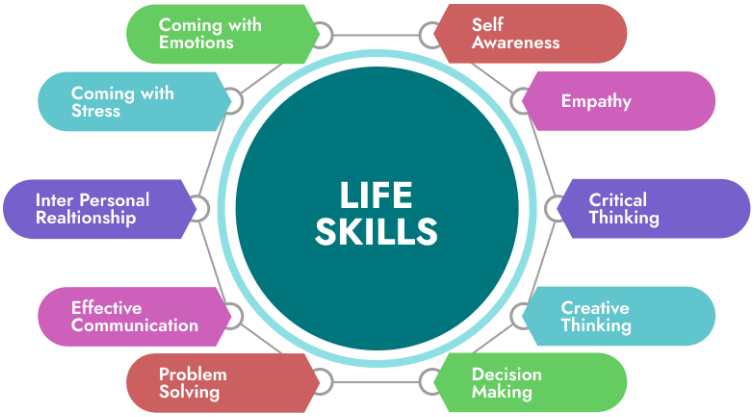


Figure 2: *Top 10 core life skills recommended by WHO*

The levels of attention, motivation and methods of interaction in the work groups were also monitored through systematic observations.

3.2. Statistical Analysis

Life and digital skill scores were analyzed through a non-parametric approach, as they did not address the basic requisite of homoscedasticity; thus, significant differences were pointed out through the multiple comparison test by Kruskal-Wallis ($P<0.05$), and boxplot figures.

As a second step, data were standardized and reported as score increase (difference in the score after and before the application of the teaching methodology); these data were also analyzed through the Kruskal-Wallis test.

Statistic was done through the software Statistica for Windows, ver. 10.0, (Statsoft, Tulsa, Oklahoma, USA).

Finally, the average percentage increases between the values recorded at input (t_0) and output (t_1) were calculated for both the 10 life skills and the 5 areas of digital competence observed.

3.3. Results and Discussion

3.3.1 Life skills

Generally, Lego-*Kintsugi* methodology determined a significant increase of all life skills scores; some representative results are in figures 3-5. Namely, at baseline empathy (Figure 3) was not different in the three-years of middle school, with a score median value ranging from 4 to 5. Exit value showed a significant increase to median values of 8-9, although the 2nd year (median at 9) was significantly different from 1st one (median at 8).

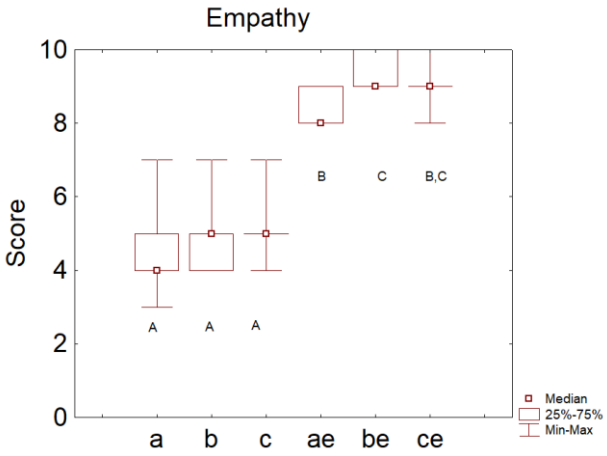


Figure 3: *Boxplot for the scores on empathy. Capital letters indicate significant differences (Multiple comparisons and Kruskal-Wallis test, P<0.05). a, b, c: scores for 1st, 2nd, and 3rd years at the beginning; ae, be, ce: scores for 1st, 2nd, and 3rd years at exit.*

The results for "Decision making" are in figure 4; as expected, at baseline the students of the three years had different levels, with a significant median score higher for the 3rd year (value at 5) than 2nd and 1st year (median at 4-5). Moreover, the statistical distribution evidenced by the boxplot suggests a gradual increase of this skill during the lifecycle of a middle school student, as for the pupils of 1st year the distribution was quite homogenous with minimum, and quartiles values at 4, while for the students of 2nd year, although not significantly different from the 1st year, an heterogeneous distribution was found, thus suggesting a different behaviour and trend among the pupils; finally, for the distribution of 3rd year students the median score experienced a significant increase.

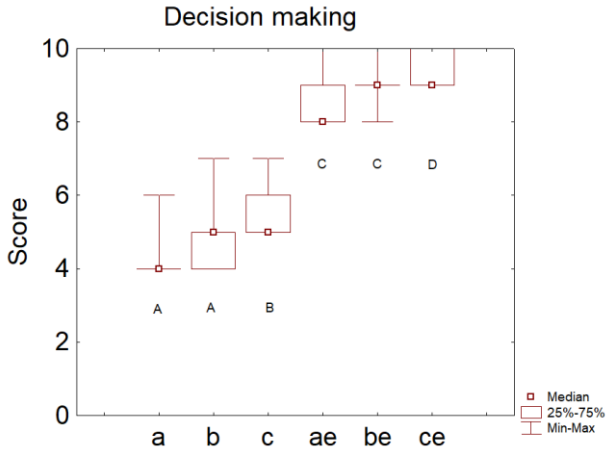


Figure 4: *Boxplot for the scores on decision making. Capital letters indicate significant differences (Multiple comparisons and Kruskal-Wallis test, P<0.05). a, b, c: scores for 1st, 2nd, and 3rd years at the beginning; ae, be, ce: scores for 1st, 2nd, and 3rd years at exit.*

After the use of the Lego-*Kintsugi* methodology all median scores increased to 8-9. The same trend, with a different baseline for the pupils of the 3 years and an increase of score median values was also found for "Interpersonal relationship" (Figure 5).

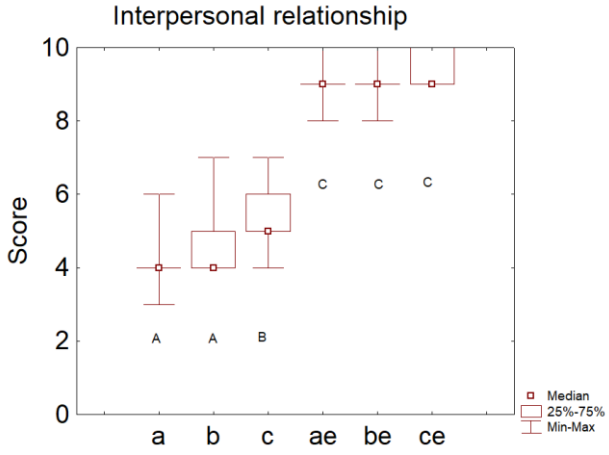


Figure 5: *Boxplot for the scores on interpersonal relationship. Capital letters indicate significant differences (Multiple comparisons and Kruskal-Wallis test,*

P<0.05). a, b, c: scores for 1st, 2nd, and 3rd years at the beginning; ae, be, ce: scores for 1st, 2nd, and 3rd years at exit.

All other skills are in table 3; at baseline the median scores were at 4-5 and the differences among the pupils of the different years were not significant. Then, these values experienced a significant increase after the application of Lego-*Kintsugi* methodology up to median values of 8-9.

	Before			**After**		
	1st year	**2nd year**	**3rd year**	**1st year**	**2nd year**	**3rd year**
Self-awareness	4 [3-4] A	4 [4-5] A	4 [4-5] A	8 [8-9] B	9 [8-9] B	9 [8-9] B
Empathy	4 [4-5] A	5 [4-5] A	5 [5-5] A	8 [8-9] B	9 [9-10] C	9 [9-9] B,C
Critical thinking	4 [4-4] A	4 [4-5] A	5 [4-5] A	8 [8-8.75] B	9 [8-9] B	9 [8-9] B
Creative thinking	5 [5-6] A	5 [5-6] A	6 [6-6.75] A	9 [9-9.75] B	9 [9-9.75] B	9 [9-9.75] B
Decision making	4 [4-4] A	5 [4-5] A	5 [5-6] B	8 [8-9] C	9 [9-9] C	9 [9-10] D
Problem Solving	4 [4-5] A	5 [4-5] A	5 [5-6] A	9 [8-9] B	9 [8-10] B	9 [9-10] B
Effective communication	4 [4-4.75] A	4 [4-5] A	5 [5-6] A	8 [8-9] B	8 [8-9] B	9 [8-9] B
Interpersonal relationship	4 [4-4] A	4 [4-5] A	5 [5-6] B	9 [9-9] C	9 [9-9] C	9 [9-10] C
Copying with stress	4 [4-4] A	4 [4-5] A	4 [4-5] A	8 [7-8] B	8 [8-8] B	8 [8-9] B
Copying with emotions	4 [4-4] A	4 [4-5] A	5 [4-5] A	9 [9-9] B	9 [9-10] B	9 [9-9] B

Table 3: *Median values, 1st, and 3rd quartiles in the square brackets for the life skills. Letters indicate significant differences (Multiple comparisons and Kruskal-Wallis test, P<0.05).*

The results obtained from the statistical analysis show an increase in the average percentage values of the entire sample studied on all the life skills studied. In particular, figure 6 highlights these increases and although there was a percentage increase of more than 30% for all the variables observed, Copying with emotions and Interpersonal relationship were found to be the two life skills most strengthened (Figure 6).

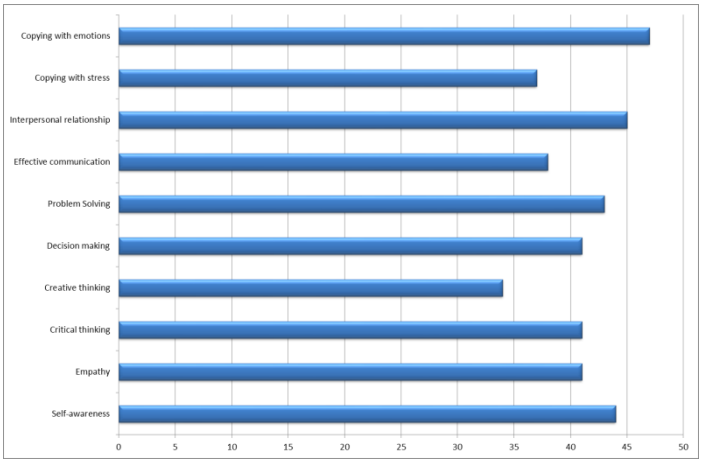


Figure 6: *Soft skills assessment (Average percentage increases).*

3.3.2 Digital Life skills

The effect of Lego-*Kintsugi* methodology on the digital skills is in table 4. The skills are grouped in five classes, named from "Digital skills 1" to "Digital skills 5" and for all a multiple comparison statistic was done to point significant differences between the score before and after the application of Lego-Kintsugi approach, as well as among pupils of different years.

Many skills were not significantly different at baseline among the three-years pupils, but there were some exceptions to this generalized statement, for example for the skills 1.3 (Managing data, information and digital content), 2.5 (Netiquette), 2.6 (Managing digital identity), 3.3 (Developing digital content), 4.3 (Protecting health and well-being), 4.4 (Protecting the environment), 5.1 (Solving technical problems), 5.2 (Identifying needs and technological responses), and 5.3 (Creatively using digital technologies), for which 3rd year students showed a higher median score.

The application of the teaching approach determined a significant increase of median score values for all digital skills, and generally at exit the differences among the three years were not significant, except for the digital skill 2.1; in this case, 3rd year pupils showed an exit score higher than 1st and 2nd year students, with a median value of 10.

	Before			**After**		
	1st year	**2nd year**	**3rd year**	**1st year**	**2nd year**	**3rd year**
Digital skills 1						
1.1	4 [4-5] A	4.5 [4-5] A	5 [5-5] A	7 [6-7.25] B	7 [6.75-8] B	8 [8-8] B

1.2	2.5 [2-3] A	3 [3-3] A	3 [3-3] A	5 [4-5.25] B	5 [5-6] B	6 [5.75-7] B
1.3	3 [3-4] A	4 [4-5] A	5 [5-6] B	7 [7-8] C	8 [7-8] C	8 [8-9] C
Digital skills 2						
2.1	7 [7-8] A	7 [7-8] A	7 [7-8] A	9 [8-9.25] B	9 [9-10] B	10 [10-10] C
2.2	6 [6-6] A	6 [6-6] A	6 [6-6] A	8 [7-8.25] B	8 [8-9] B	9 [8.75-10] B
2.3	4 [4-5] A	5 [4-5] A	5 [5-6] A	7 [7-8] B	8 [7-8] B	8 [8-9] B
2.4	5 [5-5] A	5 [5-6] A	5 [5-6] A	9 [9-9] B	9 [9-10] B	9 [9-10] B
2.5	2 [2-3] A	2 [2-3] A	3 [3-4] B	6 [6-7] C	6 [6-7] C	7 [7-8] C
2.6	2 [2-3] A	2 [2-3] A	3 [3-3] B	4 [4-4] C	4 [4-5] C	5 [5-5.25] C
Digital skills 3						
3.1	4 [4-5] A	5 [4-5] A	5 [5-6] A	9 [9-9] B	9 [9-9] B	9 [9-10] B
3.2	5 [5-5] A	5 [5-6] A	5 [5-6] A	9 [8-9.25] B	9 [9-10] B	10 [10-10] B
3.3	3 [3-4] A	3 [3-4] A	4 [4-5] B	7 [7-8] C	7 [7-8] C	8 [7-8] C
3.4	2 [2-2] A	2 [2-3] A	3 [2-3] A	8 [8-9] B	9 [8-9] B	10 [9-10] B
Digital skills 4						
4.1	2 [1-2] A	2 [2-2] A	2 [2-3] A	6 [5-6] B	6 [6-6] B	6 [6-6] B
4.2	1 [1-1] A	2 [1.75-2] A	2 [2-2] A	4 [4-5] B	5 [4-5] B	5 [4-5] B
4.3	2 [2-3] A	2 [2-3] A	3 [3-4] B	6 [6-7] C	6 [6-7] C	6 [6-7] C
4.4	3 [3-4] A	4 [3-4] A	5 [4-5] B	7 [7-8] C	8 [7-8] C	8 [7-8] C
Digital skills 5						
5.1	3 [3-3] A	3 [3-4] A	4 [4-5] B	8 [8-9] C	9 [8-9] C	10 [9-10] C
5.2	2 [2-3] A	2.5 [2-3] A	4 [3-4] B	8 [8-9] C	9 [8-9] C	10 [9-10] C
5.3	2 [2-3] A	2.5 [2-3] A	4 [3-4] B	7 [7-8] C	8 [7-8] C	8 [8-9] C
5.4	2 [2-2.25] A	2 [2-3] A	3 [3-4] B	7 [6-8] C	7 [7-8] C	8 [8-9] C

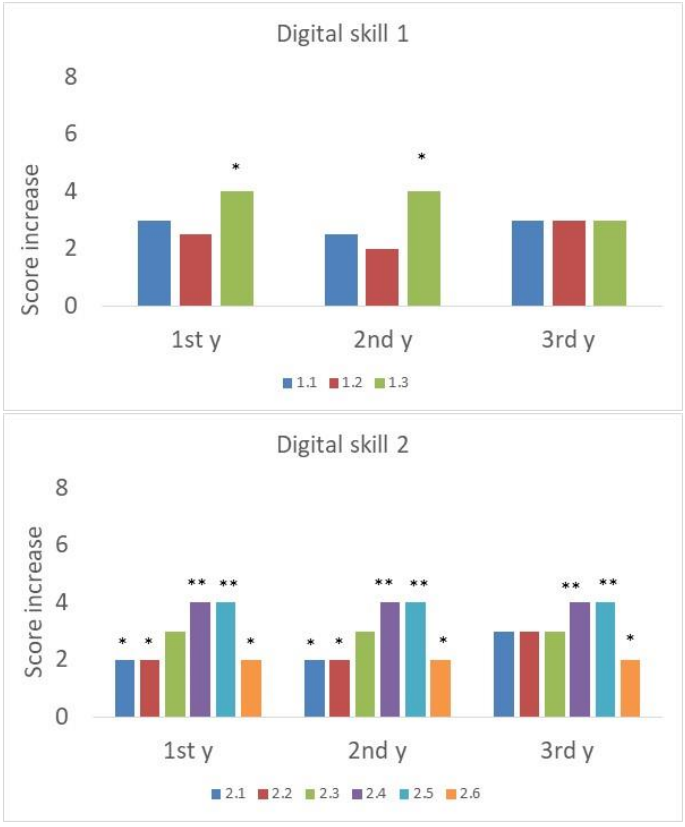
Table 2: *Median values, 1st, and 3rd quartiles in the square brackets for the life skills. Letters indicate significant differences (Multiple comparisons and Kruskal-Wallis test, P<0.05).*

For all digital skills, a focus on the increase values, that is the difference between the score between and after of the application of Lego-*Kintsugi*

methodology, was done as the analysis of raw values suggest different effects on the digital skills (Figure 7).

For the digital skills of the class 1, the median increase of scores was from 2 to 4; it is worth mentioning that while for 3rd students the skills were affected in the same way (median increase at 3), it is interesting to point out the effect for 2nd and 1st year students, as a higher increase was found for the skill 1.3.

Concerning the digital skills of the group 2, the most affected ones were 2.4 and 2.5 (median increase of 4), for all years while the skill 2.6 showed for all students the lowest median increase (values at 2); for 1st and 2nd year students a low increase was found also for the skills 2.1 and 2.2. Also, for the digital skills of the group 3, there was a skill mostly affected, with a median score increase of 6-7, that is the 3.4 (Programming). Finally, for the skills of the groups 4 and 5, the median increase values were not significantly different.



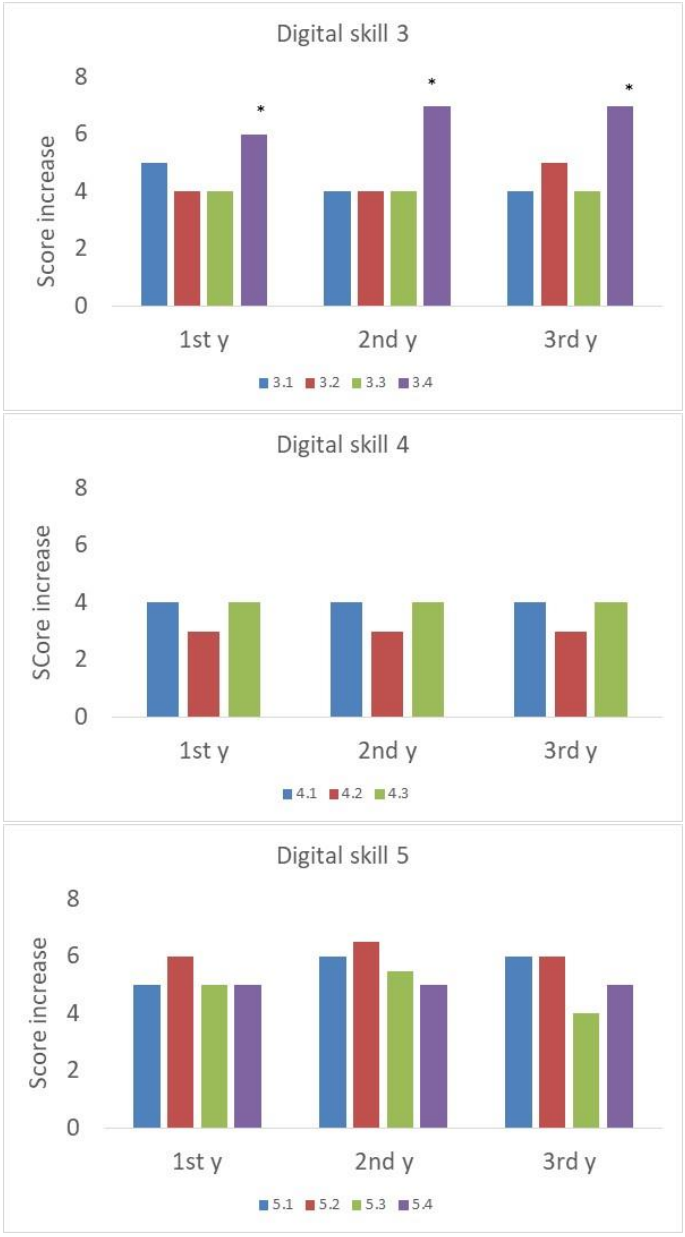


Figure 7: *Median score increase for digital skills. The symbols "*" or "**" denote a significant difference within each year.*

The results obtained from the statistical analysis show an increase in the average percentage values of the entire sample studied on all the digital soft skills studied.

In particular, Figure 8 shows the average percentage values of the observations carried out by the tutor teachers on the 5 digital life skills (five competence areas, dimension one) calculated on the entire sample, both at the beginning and at the end of the project.

Digital content creation and Problem solving were found to be the two most enhanced digital skills.

Furthermore, although there was a percentage increase of more than 30% for all the variables observed, Problem Solving and Digital Content Creation were found to be the two digital life skills most strengthened (Figure 9).

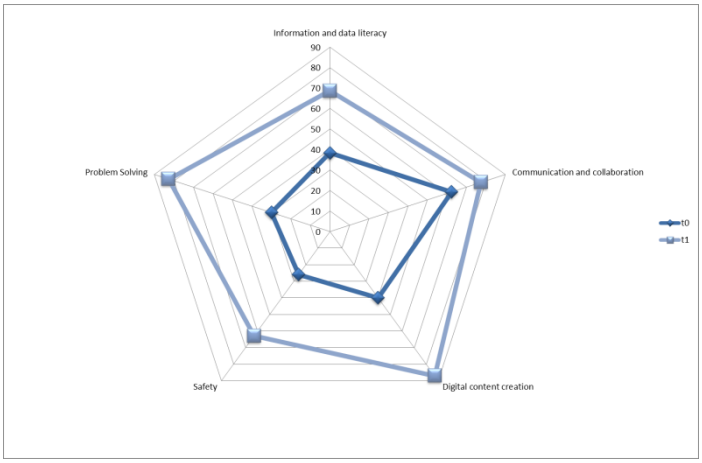


Figure 8: *Digital soft skills assessment (Avarage percentage values, t0 and t1).*

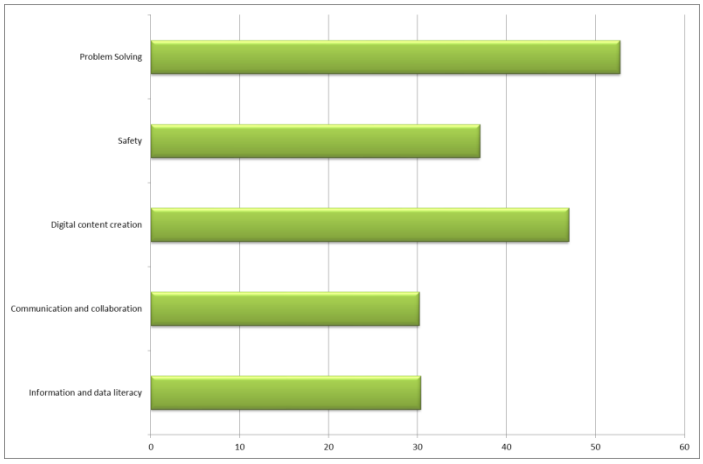


Figure 9: *Digital Soft skills assessment (Average percentage increases).*

Conclusions

The obtained results show how the use of LEGO® Education SPIKE™ Prime teaching and its lesson plan promotes an improvement in students' digital skills, with particular reference to students with special educational needs (data not shown), allowing them to “funcion” as people capable of learning withoutu difficulty, in an environment that promotes well-being and happiness (Ruggiero et al. 2021).

The teachers' perceptions, in this sense, attest to how much digital programming helps to develop problem solving and the creation of digital content in a creative way, through effective collaboration, improving communication skills between peers.

Furthermore, the use of the practice of *Kintsugi* in the personalized reworking of the robotic prototypes created, and the reflection on the importance of the error and the ability to start from the error itself in order to make an improvement on oneself, has certainly had a positive influence on the strengthening of life skills, particularly the ability to manage and copy with emotions.

Also in this case a more positive result was highlighted for pupils with special educational needs for which an increase in levels of attention, motivation and methods of interaction within the work group was observed (data not shown).

Technology, therefore, becomes “emotional”, capable of promoting the well-being of the users (Villani et al., 2011).

In conclusion, Lego-*Kintsugi*, can be considered a new teaching method for STEAM disciplines that integrates emotional intelligence with the skills required for the development of artificial intelligence systems and can represent a new way of "doing teaching" aimed at overcoming fragility and healing small "*daily cracks*" through storytelling and emotional meta-reflection, (Olivieri, 2020) and capable of enriching the school environment with well-being by promoting happiness and the valorization of talents (Margiotta, 2016).

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References

Altakhayneh, B. (2020). The Impact of Using the LEGO Education Program on Mathematics Achievement of Different Levels of Elementary Students. *European Journal of Educational Research, 9*(2), 603-610.

Bevilacqua, A., & Filippone, A. (2023). Divulgazione scientifica e didattica della Microbiologia. Un modello di didattica innovativa in una scuola secondaria di primo grado. *MeTis-Mondi educativi. Temi indagini suggestioni, 13*(2), 68-84.

Carruba, M.C. (2015). Tecnologie per l'inclusione e la promozione del benessere a scuola. *TD Tecnologie didattiche*, *23*(3), 190-192.

Cliburn, D. C. (2006, October). Experiences with the LEGO Mindstorms throughout the undergraduate computer science curriculum. In *Proceedings. Frontiers in Education. 36th Annual Conference* (pp. 1-6). IEEE.

Dato, D., Cardone, S., Di Pumpo, M., Filippone, A., Paoletti, F., Romano, C., & Ruggiero, F. (2021). I DADA TEAMS: un'esperienza di didattica innovativa. *MeTis-Mondi educativi. Temi indagini suggestioni, 11*(2), 292-306.

Disseler, S., & Mirand, G,. (2017). Students with Disabilities and LEGO Education. *Journal of Education and Human Development, 6*, 38-52.

Fattorini, O. (2022). Il Modello DADA (Didattiche per Ambienti Di Apprendimento): paradigma di una governance innovativa delle istituzioni scolastiche italiane.

Harris, O., Lawes, A., Andrews, C., & Jacobsen, P. (2022). Kintsugi – Identity change and reconstruction following an episode of psychosis: A systematic review and thematicsynthesis. *Early Intervention in Psychiatry*, 16, 689-714.

Irgen-Gioro, J. J. Z. (2016). Teaching artificial intelligence using Lego. In *Proceedings of the international conference on frontiers in education: computer science and computer engineering (FECS)* (p. 209). The Steering Committee of The World Congress in Computer Science, Computer Engineering and Applied Computing (WorldComp).

Kinchin I. & Winstone N. (Eds.) (2017) *Pedagogic frailty and Resilience in the University*. Rot-terdam: Sense.

Klassner, F. (2002, February). A case study of LEGO Mindstorms'™ suitability for artificial intelligence and robotics courses at the college level. In *Proceedings of the 33rd SIGCSE technical symposium on Computer science education* (pp. 8-12).

Levy, J., & Dunsmuir, S. (2020). Lego therapy: Building social skills for adolescents with an autism spectrum disorder. *Educational and Child Psychology, 37*(1), 58-83.

Margiotta, U. (2016). Una "buona scuola" potrà generare una "scuola dei talenti"?. *Scienze e Ricerche*, 23, 15-17.

Navarro, T. (2018). *Kinstukuroi. L'arte giapponese di curare le ferite dell'anima*. Firenze: Giunti Editore.

Olivieri, D. (2020). Costruzione dell'identità narrativa e formazione dei talenti in adolescenza: indagine sul potere trasformativo dello storytelling. *Formazione e insegnamento*, 18, 634-652.

Olivieri, D., & Cardinali, C. (2021). The path of transformation towards the new"normal" in the time of Covid-19: from the pedagogy of vulnerability to the pedagogy of resilience. *Formazione & Insegnamento, 19*(1 Tome I), 296–315.

Ruggiero F., TorregrossaT., & Filippone A. (2021). L'esperienza del per-corso "L'ora della felicità" all'interno del curricolo della Scuola Fo-scolo-Gabelli. In D. Dato, S. Cardone & C. Romano (a cura di), *L'ora della felicità. Riflessioni pratiche per la promozione delle life skills a scuola* (pp. 95-99). Bari: Progedit.

Santini C. (2018) *Kintsugi. L'arte segreta di riparare la vita.* Milano: Rizzoli.

Santini, C. (2019). *Kintsugi – Finding strength in imperfection.* Andrews McMeel Publishing.

Souza, I.L.M., Andrade, W.L., Sampaio, L.M.R., & Araujo, A.L.S.O. (2018). A Systematic Review on the use of Lego Robotics in Education. *IEEE Frontiers in Education Conference (FIE).*

Talaga, P., & Oh, J. C. (2009). Combining AIMA and LEGO mindstorms in an artificial intelligence coursetobuild realworldrobots. *Journal of Computing Sciences in Colleges*, 24(3), 56-64.

Tavera, I. H. P. (2022). Lego Education-Spike Prime. *Vida Científica Boletín Científico de la Escuela Preparatoria No. 4, 10*(19), 9-11.

Villani, D., Grassi, A, & Riva, G. (2011). *Tecnologie emotive. Nuovi media per migliorare la qualità della vita e ridurre lo stress*. Milano, IT: LED Edizioni Universitarie.

Vuorikari Rina, R., Kluzer, S., & Punie, Y. (2022). *DigComp 2.2: The Digital Competence Framework for Citizens-With new examples of knowledge, skills and attitudes* (No. JRC128415). Joint Research Centre (Seville site).

World Health Organization, WHO. (1996). Planning for research as an integral part of life skills education development, implemetation and maintenance.