

A pedagogical framework and Evaluation of STEM & Robotics Camp Programs. A case-study.

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Abstract : In many cases, the informal education of young people has played a key role in shaping attitudes and decisions about their future (Dieker, L. et al, 2012). Summer camps are undoubtedly additional opportunities for children to learn new and interesting topics, which later might become their choice for a more in-depth study and specialization. Short-term STEM and robotic summer programs are quite popular in various parts of the world (Capelli et al. 2019). The main goal of these kind of camps is the enjoyable and creative employment of children through programs that offer them the opportunity to gain experience about recent technologies such as Robotics, programming, 3D printing and other creative activities. This paper aims to highlight some critical parameters of a pedagogical framework that could be used for building up successful STEM camp programs. Moreover, a questionnaire which examines how dimensions like confidence, content knowledge, persistence, ease of use of the robotic platforms and the satisfaction of the participants aging 9-14 has been created and pilot evaluated during this case study.

Keywords: STEM approach, 21st century skills, STEM camp programs,

1. The STEM approach: Definition and Benefits.

STEM has been one of most emerging issues in the field of education the last two decades. The acronym is formed from the initials of the names of Science, Technology, Engineering and Mathematics and refers to an educational methodology which recognizes the need to utilize knowledge from all four fields in order to end up into the most effective solution of everyday life problems (Eguchi, 2014; Bybee, 2013; Dugger, 2010).

It is considered an effective method that helps students to strengthen their knowledge in the above areas, and moreover helps them develop some important intrinsic characteristics required for effective problem solving like persistence and patience (Kind & Wiseman, 2001; Smith &Karr-Kidwell, 2000). Research has shown that when STEM approach is applied, students succeed in becoming more effective thinkers, act independently and show more initiative (Kind & Wiseman, 2001; Smith &Karr-Kidwell, 2000). Furthermore, STEM is an approach that favors the utilization of important student-centered learning strategies, such as inquiry, in which students are actively involved in a problem-solving process, by seeking information and tools (Altin & Pedaste, 2013; Lantz, 2009).

Research findings also show that the earliest explosion of children into STEM activities ends up in better results in terms of knowledge and skills that are developed (McClure, E. R. et al. 2017). However, finding effective strategies that prepare students with a prominent level of knowledge and skills, motivate and increase their interest in order to pursue studies related to the field remains a big challenge (McClure, E. R. et al. 2017). STEM approach aims to increase the learning outcomes and lead more people to pursue professional careers in fields related to new technologies (Heilbronner, 2011; Holmegaard et al., 2012).

In 2013, aiming to push more countries to adopt this methodology, the STEM Education Committee in America strongly stated the position that future work will be intertwined with skills developed through STEM, drawing the interest of many education systems into this direction (Committee on STEM Education National Science and Technology Council, 2013).

Today, STEM is not only found in education, but extensive efforts are being made by many organizations and companies for 'growth' and 'innovation', whilst significant funds are being invested in the development of human resources that are "equipped" with modern knowledge and skills that are related to STEM (West, M., 2012)

STEM programs offered as part of summer camps are a unique opportunity for children to engage in extensive STEM-related activities and robotics (Capelli et al. 2019). However, it is important that such programs meet basic requirements and add value to the overall effort of providing quality education to children (Capelli et al. 2019). This article provides a detailed analysis of a STEM curriculum, specially designed for the needs of a summer STEM camp program. Emphasis has been put on determining the pedagogical framework that it's considered to be more appropriate for these kinds of programs, as well as important skills that can be developed, which are really important for the readiness of young people to confront 21st century's challenges.

2. Defining the 21st century skills

It is widely accepted that our age is characterized by the digitization in all sectors of the economy such as health and safety, education, industry, and trade. Our everyday life has been transformed in a way that we need to use the digital world for every single activity: from filling up our car with fuel or for ordering food or clothes via online shops. Aiming to equip children with contemporary knowledge and skills many education systems have put emphasis on the development of important skills which are considered to be more important qualifications that would help individuals acting independently in this new world (Beetham & Sharpe, 2007· Binkley et al., 2012· Caldwell & Longmuir, 2010· Cisco, 2010· Hadjileontiadou & Kasimatis, 2014· Kalantzis & Cope, 2008· Κασσιμάτη, 2005· Mayer, 2003· Partnership for 21st Century Skills, 2009). Based on Binkley et al. (2012) special skills must be developed during the training period of the students in order to be efficiently prepared for the global demand of labor. Skills like innovation and creativity, critical thinking, problem solving, decision making, learning how

to learn, communication, collaboration, digital literacy, personal and social responsibility considered to be the most important ones (Binkley et al., 2012).

These skills seem to be difficult to be developed in the existing learning environments with traditional teacher-centered methodologies, teaching tools and curriculum. It's obvious that contemporary teaching approaches are the way to success. The key features of modern dynamic learning environments are:

- combine the possibilities offered by information technology with all the applications that exist to meet challenges regardless of the subject matter.
- they promote collaboration and interactivity among the students or between the students and their teacher.
- They include the elaboration of solo or group projects that encourage learning based on the same framework that governs the scientific discovery of knowledge starting with the formulation of research questions and continuing with the research, design and implementation of an experiment, recording results and drawing conclusions and verifying research questions.
- They enhance critical and creative thinking as a result of the constant and imperative need to find solutions to problems by the students themselves.
- They encourage the development of meta-cognitive skills such as self-regulation, reflection and self-evaluation.
- Recognize that the solution to modern problems lies in the interdisciplinary use of knowledge as an inevitable and necessary fact (Binkley et al., 2012)

3. Conditions for successful organization of STEM camp programs

Summer camps have been part of children's lives for decades, as they create memories, build strong friendship and develop lifetime skills. STEM training-focused camps continue to gain popularity due to the variety of activities they offer and the interesting topics (Binns, I. C., Polly, D., Conrad, J., & Algozzine, B.,2016 · Conrad, J., Polly, D., Binns, I., & Algozzine, B., 2018· Capelli et al. 2019)

STEM camps have an amazing learning potential and can broaden students' horizons, but they are still summer activities and should retain their fun and engaging style. For this reason, it is important that besides the educational activities, time for fun and joy is allocated in the daily program (Binns, I. C., Polly, D., Conrad, J., & Algozzine, B.,2016 ·Capelli et al. 2019).

The success of a STEM camp is mainly based on the 4 pillars described below:

- *Organized and well-structured educational activities, which are understandable and attractive, both at the cognitive level and in the selected topics.*

It is very important to emphasize that depending on the style and character of the STEM camp the theme of the educational activities should incorporate various aspects of the STEM education. The integration of robotic constructions and programming is proven to be a successful way of combining modern methods and new technologies. The choice of activities should respect the different cognitive background of the children and build in a structured way the necessary knowledge and skills, so that the children can develop their work (Crombie et al., 2003; Nugent et al., 2010)

- *Development of teamwork and cooperation with open activities. The teaching and speaking time by the trainers should be minimal, while the result of the work should be part of a broad topic with multiple approaches.*

Children are more likely to develop their own ideas than to follow specific instructions. Open-ended work favors the development of original ideas that try to solve an existing problem of everyday life like topics related to ecological problems, global warming, recycling, road behavior and health problems are considered ideal for stimulating children's creativity and innovation (Barak M. & Assal M., 2018). The role of the trainers should be more advisory than guiding, so that the children feel that they are in control of their own work, while any suggestions and help from the trainers will seem additional to them only to improve their idea trial (Affouneh et al., 2020)

- Comfortable space and adequate equipment

Choosing a suitable space and equipment is also considered an important parameter for the success of such programs (Yuen, T., Ek, L., Scheutze, A., 2013·Yamamori, K. (2019). The ideal is to have enough space and material, allowing children to comfortably build, test and perform experiments with their models. Appropriate infrastructure such as a projector, a good sound system and adequate components for open-ended projects are also considered necessary for the smooth execution of children's tasks. Based on the above the STEM programs organized by ENGINO® are usually carried out in hotel complexes that provide a comfortable conference room, which is well equipped and all that remains is for the trainers to take with them the Robotic kits plus additional materials that use in leisure activities

- Fun and original activities, independent or not to STEM themes, in order to cultivate further activities such as sports and gymnastics, the development of social skills and the emergence of individual talents of children.

In addition to developing social relationships between children, leisure activities offer the opportunity to show children multifaceted - and often hidden - potential. For example, through sports activities, the abilities and performance of children may appear and shine, who may have felt less strong in the main activities. Also, through artistic activities such as singing (karaoke) and dancing, children can project a different aspect of their character and help them feel more familiar with each other. However, what is a concern when planning the daily program of a STEM camp is that even the entertainment activities to be interspersed with knowledge, skills and values that will help children to develop in many ways (Moreno, N. P., Tharp, B. Z., Vogt,

G., Newell, A. D., & Burnett, C. A. 2016). In another case even an organized raffle game can be transformed to suit the character of the camp. In this case the children who fill in a line in their raffle are asked to answer a question related to the STEM fields and to win a gift if they answer correctly.

4. Research objectives of the study

Investigating mainly the feelings of participants in STEM summer programs is considered to be the best practice due to the short duration of a camping program. (Capelli et al. 2019). In the context of such a program, which also concerns the present study, it was deemed appropriate to investigate the variables related to how the children felt during the program. For this reason, research questions focus mainly on exploring variables such as children's perceptions of how easy the program was, whether it affected their persistence in performing various tasks, and whether the program was a pleasant experience for them.

More specifically, this study aims to answer to below questions?

1. Were the robotic platforms easy to use?
2. Was the software easy to use?
3. Were STEM lessons enjoyable?
4. How did the STEM camp program influence children’s confidence in STEM?

5. STEM summer camp programs with ENGINO®

In response to the above research questions, the STEM and robotics program that Engino® organizes was thoroughly examined as the company has been a pioneer in summer STEM & Robotic camps since 2015 when its first Robotic platform had kickstarted. The camps have an international character and host both Greek-Cypriots and foreigners. For this reason, both Greek and English languages are used during the workshops.

The main purpose of these camps is to offer opportunities for young children to learn, engage and be interested in modern forms of technology that seem to be significantly penetrating the contemporary world (National Center on Education and the Economy, 2008; National Science Foundation & National Science Board, 2015). During the camps new ideas and developments are tested and finetuned. Following the interdisciplinary teaching approach of various modules coming mainly from the fields of STEM, these programs aim to offer a wide learning experience in topics like levers, linkages, structures, pulleys or Newton's laws of motion together with coding for the programming of the models.

5.1. Robotized construction kits (RCKs) as the main material of the program

The robotized construction kits that are used during the programs have been designed to serve multiple teaching goals such as: enhance learning of how robots work, being utilized as manipulatives to support teaching of domains like Physics, Math and Engineering, facilitate interdisciplinary methodology of teaching, develop children’s dexterity skills such as hand-eye coordination as well as other important 21st century skills like critical thinking, problem thinking, creativity and collaborative work.

The system is mainly consisted of rods that they just snap fit together and easily can be connected linearly (in one direction) or side way (two ways). The system is also capable of tackling with the same ease all other building directions of the 3D space once the rods are combined with various other types of connectors specially designed to allow expandability at any direction and at any angle. The different connections are presented below:

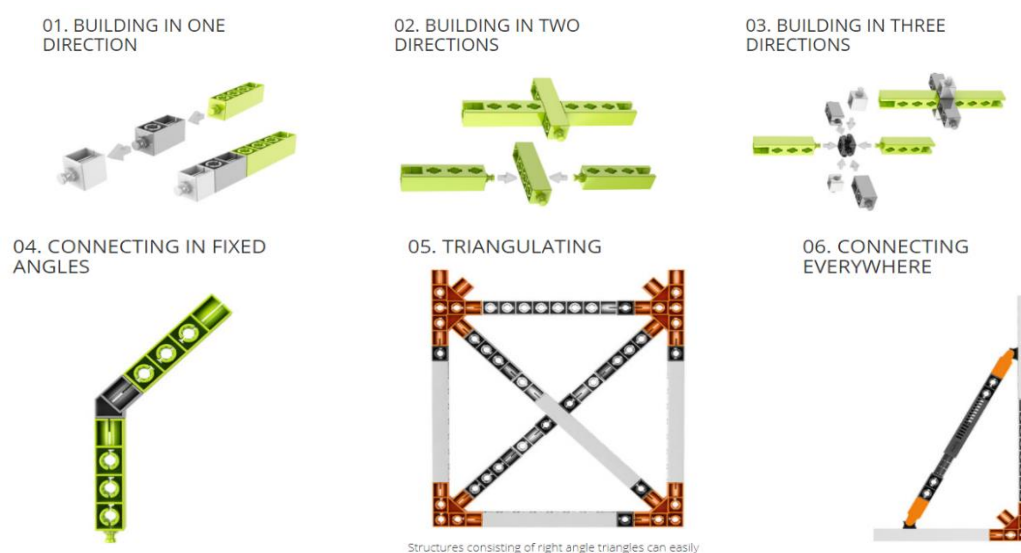


Figure 1: The Engino® building system

The building system allows multiple reconfigurations of the robotized models and seems to significantly contribute to the increase to children’s interest and knowledge in STEM (Eguchi, 2014). In addition, these programs aim to contribute to the development of children's critical thinking and to equip them with sufficient content knowledge from the fields of STEM that would enable them to solve everyday problems in a creative and innovative way (Eguchi, 2014; Cappelli, C. J., Boice, K. L., & Alemdar, M. 2019). The programs utilize different robotic platforms such as the ERP® PRO, ERP® MINI, PRODUINO and GINOBOT specially designed for young learners ageing from 9-14+ years old. A brief description about each platform is presented below:

a) STEM& ROBOTICS MINIERP® MINI



Figure 2: Engino® STEM& Robotics MINI set

The STEM & Robotics Mini education set is especially designed for Primary school students of ages 6-9. It combines the core subjects of STEM together with Robotics. The set contains large number of Engino and QBOITZ plastic parts, allowing the construction of 38 STEM models. It also includes robotic parts such as the Mini controller, RJ cables, two InfraRed sensors, one Touch sensor, one LED, two motors and a USB cable! The KEIRO™ software provides a Scratch – like user friendly environment for coding. The activities begin with the basic principles of STEM related subjects together with robotics using easy to build models. Then, they move on to more complex concepts of programming with the introduction of sensors, conditional statements and logic gates.

b) STEM& ROBOTICS PRO -ERP®- PRO

The STEM & Robotics PRO education set is especially designed for late Primary and Secondary school students of ages 8-15. It combines the core subjects of STEM together with Robotics. The set comes in a convenient plastic storage tub that contains large number of Engino parts, allowing the construction of 34 STEM models. It also includes robotic parts such as the PRO controller, RJ cables, one Touch sensor, two InfraRed sensors, three Motors, five LED lights and a USB cable! The KEIRO™ Software provides a Scratch – like user friendly environment for coding. The activities begin with the basic principles of STEM related subjects together with robotics using easy to build models. Then, they move on to more complex concepts including sensors, conditional statements, variables, functions and operators.



Figure 3: Engino® STEM & Robotics PRO set

c) STEM & ROBOTICS PRODUINO -ERP®- PRODUINO

The STEM & Robotics PRODUINO education set is designed for Secondary and High school students of ages 14+ and even hobby engineers. It covers effectively the core subjects of STEM together with Robotics and Coding. The set is powered by the new advanced PRODUINO controller which has Bluetooth and Wi-Fi wireless connectivity, a USB port, a Display with 6 programming buttons, a Re-chargeable battery, a Touch sensor, a Color sensor, InfraRed sensors, an Ultrasonic sensor, a Compass/Magnetometer, DC motors and Servo motor! The innovation of PRODUINO lies in its brain, which incorporates the open-source Arduino platform, allowing 3rd party sensors, shields and even programming software to be used. The KEIRO™ software provides a Scratch-like environment with drag and drop blocks together with an Arduino mode for C++ coding. The program can run on Android and iOS tablets, Mac, Windows and even Linux





Figure 4: Engino® STEM& Robotics Produino



Figure 5: GINOBOT™

- d) Ginobot is a highly programmable robot ready to be used as a neat tool for teaching STEM disciplines, computational thinking and digital literacy. It has unlimited expansion potential, since it allows the attachment of add-on 3rd party electronics and hardware like a Raspberry Pi, Arduino and micro: bit. Besides its internal sensors and its expandability with 3rd party electronics, the body of Ginobot is also compatible with the Engino® building system to construct larger and more sophisticated robots.

5.2. STEM program methodology: Design and implementation of STEM curriculum

Aiming to provide rigorous and high-level STEM knowledge the camp’s modules are designed with plenty of hands-on activities that follow modern pedagogical learning approaches with particular emphasis on the Scientific process and the process of Engineering Design method (Nugent et al., 2010). The courses of the summer STEM programs focus on the building of modular technological models that students use during the experimentation phase before ending up into their conclusions. What is carefully embedded in the Engino’s STEM camps’ curriculum is the perception that solution to technological problems requires a series of successive actions that sometimes follow one another, and some other times require back and forth steps in certain "critical" stages till the optimal solution.

The emphasis on the "critical" stages of this process is presented by a dashed outline on the basic circular diagram of the engineering design method as shown in the figure below:

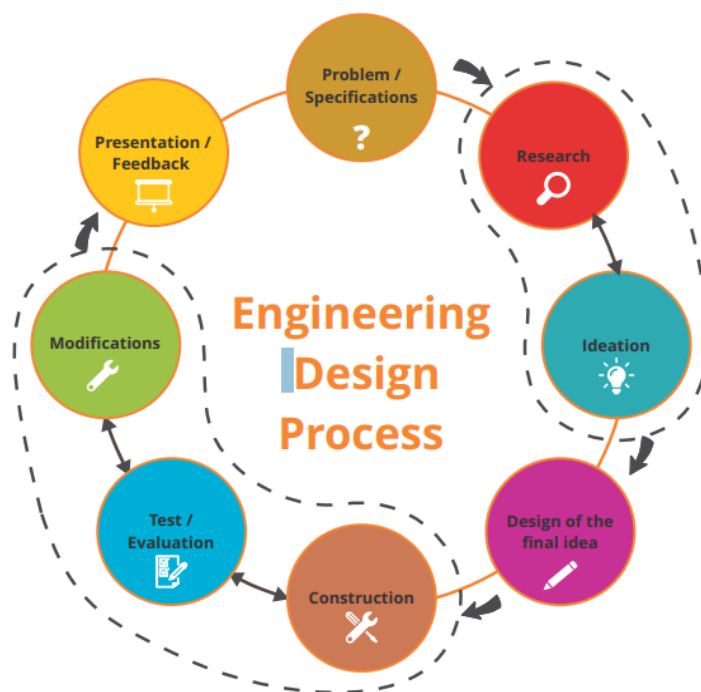


Figure 6: Adaptation of Engineering Design process diagram Reference

When for example students are looking for ideas that would solve the problem, they quite often need to make many forward and backward steps between this step and the research until they end up with the best idea/solution. Similarly, when students start building up their idea, they need to do many tests and modifications before their construction takes its final shape. All these iterations serve great pedagogical goals and equips kids with important intrinsic characteristic like being dynamic personalities who persevere and strive to achieve their goals.

Additionally, the activities of the STEM camp programs are designed in a way that promote collaboration within the group, allowing each group to operate independently and at its own pace and potential. More specifically, what is expected is how the members of each group follow and execute the instructions of each activity, observe the result, test and take appropriate actions for corrections or improvements. The most important thing of these programs is to ensure that the acquisition of knowledge is ensured through the enhancement of research, which arises effortlessly and as a necessity to end up into a solution for a specific problem. In this way the theory becomes interesting, and learners are motivated to understand it better, since it is required to confront efficiently the problem that they are dealing. Schematically the way that activities are approached is given in the graph below:

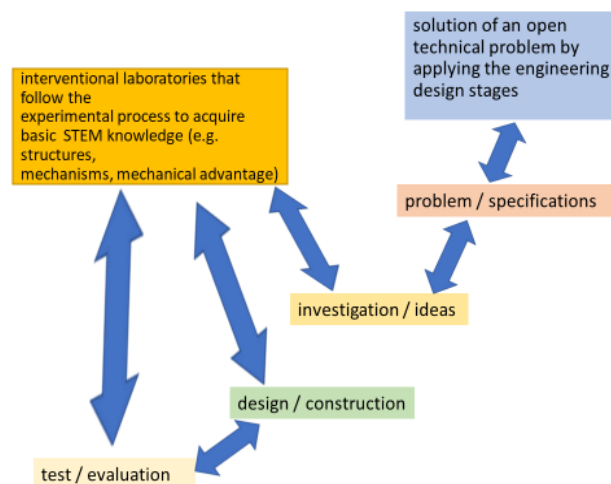


Figure 7: Proposed Methodology for teaching STEM camp programs

Based on this methodology, learning of new STEM content arises from the “need” to solve an open technical challenge. The challenges are usually problems from everyday life and are resolved partially and gradually, while students apply the information they learn on their construction. The two-way arrows, that connect the ideation phase as well as the design and testing phase with the experimental workshops reveal the inextricable link that these stages have with the sufficient relevant knowledge that the learner must obtain in order to solve the problem. The provision of sufficient scientific knowledge as well as opportunities for real understanding of how this knowledge is deployed on the models, are the keys for successful solutions to the projects that are assigned to students. In such learning environments the role of the teacher is limited to that of the facilitator who observes the progress of the children and intervenes only where needed or where they are called for help. The basic conditions for successful design of a short-term STEM camp program are analyzed in the next chapter in the article.

5.3. The timeline of ENGINO® STEM summer camp

Aiming to inspire kids the STEM summer camp begun with a visit at the ENGINO® factory! During the tour the working environment in which the research, innovation and commercial exploitation of new products takes place was presented to the kids. Children had the opportunity to see and hear professionals mainly in the company's research and development department who described their work and explained in simple words the research and development stages that follow in order to launch a new product. This year the camp was hosted in a hotel at the village Agros (in Cyprus) during the period 21st to 25th of July of 2020. The program was consisted of 20 hours of STEM activities for the period of 5 days.

During the program the children had plenty of time to get familiarized with the building system, follow instructions in order to create and program robotized models, learn how to effectively work together through collaborative games, design in a 3D application their constructions (Engino KIDCAD), learn about 3D printing and watch their own model being printed in a 3D printing machine. The children were given a camp booklet containing all the planned activities, as well as other information such as the camp timetable (see in the Appendix). The program was enriched with many edutainment games like robot battles and a different version of bingo game during which some STEM related questions were imposed to the campers. The culmination of all the activities was the open-ended work where the children had to think, construct and present their own solutions based on a common topic: “Ideas for limiting the spread of the covid-19 pandemic”. Table 1 in the Annex gives a brief description of the daily program. The educational activities which are displayed in this table in orange are explained further in the next paragraphs.

- **Introduction of the building system/Programming with ERP PRO and Ginobot**

This activity was designed in order to make all kids familiar with the building system and basic programming blocks. The kids were asked to follow instructions for building a simple robot vehicle and then program it, so that it would move in a rectangular path. Then, they were asked to make similar codes using the ready-made Ginobot robot, observe and compare the two models.



Figure 8: Children programming Ginobot and ERP Pro controller.

- **3D design with ENGINO® KIDCAD (3D Builder software)**

During this activity the kids were asked to imagine and build their own 3D model first with a specific number plastic parts, so they would first construct their concept idea by building their model. Then they used the 3D Builder software which is an in-house developed software by ENGINO® that help students design models in 3D space surface in the computer. The ultimate goal of the activity was to create a digital model which could be used for 3D printing later in classroom.

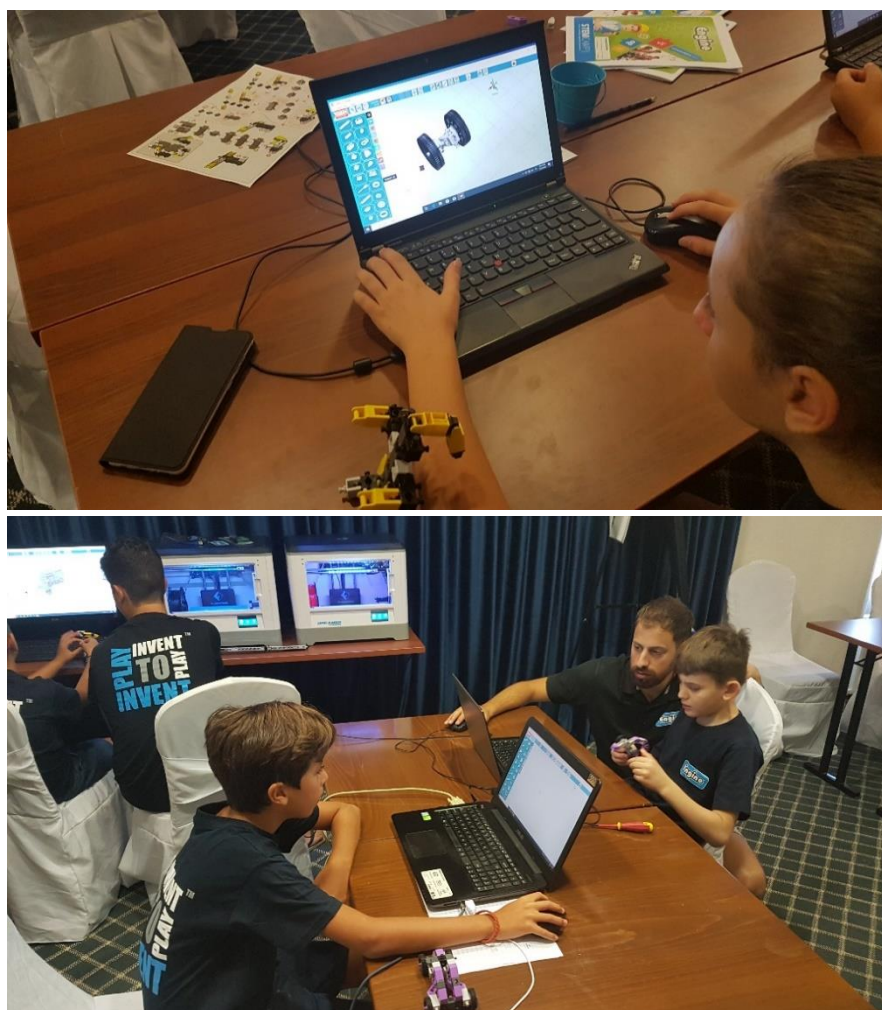


Figure 9: Children designing models on KIDCAD™ software

- **Advanced challenges with ERP pro and Ginobot**

In this workshop the main goal was to enhance kids' confidence in utilizing more complicated sensors such as color and ultrasonic sensor. The programming tasks were designed, so that kids could understand the main difference among sensors, the difference among receiving a Boolean or an arithmetic signal and how to program them appropriately.

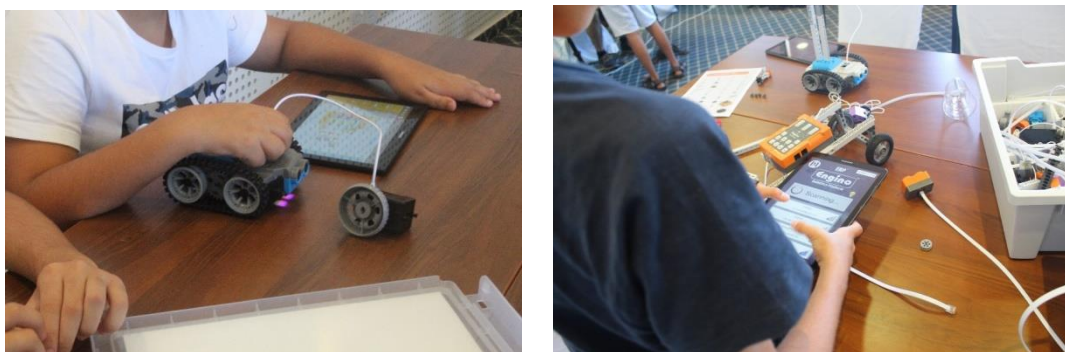


Figure 10: Children use color and ultrasonic sensors for advanced challenges with ERP pro and Ginobot

- **Presentation about 3D printing**

The activity opened with an insightful presentation about 3D printing machines, their applications and how they have transformed industry and technology the last years. Students became aware of the basic functions happening inside a 3D printing machine and observed their own models been printed in real time inside the machine.



Figure 11: Learning about 3D printing devices

- **DIY constructions for Robotic battles**

This activity has an increasing popularity at ENGINO® robotic camps, since the kids work in teams to build and fight against robots of opponents. The main goal is to expand their creativity to build large and functional models, capable to be remotely controlled by the students.



Figure 12: Robot battles at the camp

- **Open projects (ideation and construction)**

The climax of the camp was delivered by the open project task, in which the kids unleashed the full potential of their creativity, collaboration and conceptualization in order to construct a model. All teams were asked to make their own construction which could serve as a solution in hygiene and sanitation purposes. In this full day activity kids had to undergo through the engineering design process so that from an initial problem they should progress in ideation, testing and presentation of the proposed model. The culmination of the camp was the open project, in which all the teams were invited to make their own construction which could serve as a solution to a health problem. More specifically, children were introduced to various problems created due to the spread of corona virus. Through a discussion and with the instructor's guidance, the children thought of ways in which robotics could automate various activities that could stop the dispersing of the virus. In this all-day activity the children had to undergo the engineering design process, so that from the problem they could proceed to the idea, test and to present their solution.



Figure 13: Scenes from Open-projects presentations

6. STEM CAMP program evaluation. Designing a tool for measuring Methodology

The case study is the methodology followed in the present work. Due to the fear of the pandemic in Summer 2020 only 14 kids were registered at the ENGINO’S STEM camp -12 boys and 2 girls, aged from 9 to 14 years old (M = 11.42). The classroom was divided in two three-member groups and two four-member groups. Quantitative data were collected by the method of the questionnaire, whilst some qualitative data that are presenting in Four teachers (two male and two female) had taken over the design and the implementation of the program. The questionnaire was consisted of 31 statements which apply to the research questions:

The table below lists the distribution of questions in these 4 research questions:

Research questions	Questionnaire statements
1. Were the robotic platforms easy to use?	1. It was easy for me to connect the Engino® parts. 2. I feel confident using Engino® parts to build different models. 3. It was easy for me to follow the building instructions to build a model. 14. It was easy to follow the stem activities with Ginobot. 15. Using Ginobot helped me execute more precise some commands (for example turn 90 degrees right/left)
2. Was the software easy to use?	4. It was easy for me to program my robot with ERP RPO® controller. 5. It was easy for me to program manually my robot with ERP RPO® controller. 6. I found it easy connecting the below sensors and outputs: a) IR sensor, b) touch sensor, c) ultrasonic, d) color sensor, e) led, f) motors 7. I found it easy to use the KEIRO® software to program my robot. 8. I feel confident to program IR sensors. 9. I feel confident to program touch sensor. 10. I feel confident to program ultrasonic sensor.

	<p>11. I realize that programming a robot can help me understand better Math exercises.</p> <p>13. It was easy for me to program my robot with Ginobot.</p> <p>19. It was easy for me to use the EnginoBT to control my robot.</p>
3. Were educational robotics lessons enjoyable?	<p>12. I like doing programming.</p> <p>20. I found the STEM activities interesting.</p> <p>21. I like working with my team.</p> <p>22. We collaborated very well with my team during the activities.</p> <p>23. I enjoyed using Engino® parts to build models.</p> <p>24. I enjoyed programming the ERP PRO robot.</p> <p>25. I enjoyed programming the Ginobot robot.</p> <p>26. I enjoyed the STEM activities.</p> <p>27. I think the STEM program I attended during the camp was appropriate for my age.</p> <p>28. I would participate again in a STEM camp.</p>
4. How did the STEM camp program influence children’s confidence in STEM?	<p>16. I feel like I gained more knowledge about programming cause of this STEM CAMP program.</p> <p>17. I feel confident when creating my own digital model on KIDCAD® software.</p> <p>18. I liked that I created my own 3D model.</p> <p>29. I am thinking of following a STEM career in the future.</p> <p>30. Usually I give up a task if I find it difficult.</p> <p>31. STEM activities helped me to insist when doing a task.</p>

Table 1: Distribution of questions in the 4 research questions

The program was evaluated based on a five-point Likert scale questionnaire from 1 to 5, with 1 equal to Strongly Disagree and 5 Strongly Agree. Literature’s advice in evaluating short-term outcomes such as participants’ awareness, content knowledge, interest and satisfaction when evaluating summer STEM programs were seriously taken into consideration for the preparation of the 31 questions (Wilkerson and Haden, 2014;. Allen and Peterman, 2019). The

questionnaire was designed on Google forms for a convenient collection and analysis of the data (See link in the Appendix). The questions were divided into seven dimensions as shown in the table below:

Table 1. Dimensions examined during evaluation of the STEM program

Confidence	Q7, Q8, Q9, Q15, Q16
Content knowledge	Q2, Q10, Q14
Persistence	Q11, Q17, Q19, Q22, Q23, Q24, Q25
Easy to use	Q1, Q3, Q4, Q6, Q5a-Q5f, Q12, Q13, Q18
A pleasantly task	Q11, Q17, Q19, Q22, Q23, Q24, Q25
Competent	Q26, Q27, Q28, Q31
Positiveness in collaboration	Q21, Q21

7. Analysis and results

The following Table 2 presents descriptive statistics for the *factors - dimensions of this study*.

Table 1: Descriptive statistics for the factors - dimensions of this study.

	N	Minimum	Maximum	Mean	Std. Deviation
Confidence	14	2,80	5,00	4,31	0,76
Content knowledge	14	1,33	5,00	4,24	0,99
Persistence	14	1,00	5,00	2,68	0,89
Easy to use	14	2,08	5,00	4,23	0,89
A pleasantful task	14	2,57	5,00	4,39	0,74
Competent	14	1,25	5,00	3,77	1,09
Positiveness in collaboration	14	1,00	5,00	3,86	1,34

The dimension “a pleasantly task” seem to come first in the ranks with the highest mean (4,39) and smallest standard deviation showing a very positive respond of students on the questions related to this dimension. Quite close to this dimension were also the question related to the dimension “Confidence” with mean=4.31, the dimension “Content knowledge” with a mean=4.24 and the dimension” Easy to use” with mean=4.23

The Spearman’s rho correlation coefficients for the variables used in this study are presented. The Spearman’s rho correlation suggests a statistically significant positive association between

the Confidence with the Content knowledge ($r(14) = 0,811, p < 0,01$), the Easy to use ($r(14) = 0,936, p < 0,01$) and the pleasantly task ($r(14) = 0,617, p < 0,01$). Also, there is a statistically significant positive association between the Content knowledge with the Positiveness in collaboration ($r(14) = 0,677, p < 0,01$). Last, but not least, there is a statistically significant positive association between a pleasantly task and the Easy to use ($r(14) = 0,630, p < 0,05$). No other significant association found between any other combination at a 5% level of significance.

Table 2: Correlation Matrix

	Age	F1	F2	F3	F4	F5	F6	F7
Age	1							
F1: Confidence	0,061	1						
F2: Content knowledge	- 0,201	,811**	1					
F3: Persistence	- 0,327	0,386	0,362	1				
F4: Easy to use	0,034	,936**	,806**	0,293	1			
F5: A pleasantful task	0,022	,617*	0,293	0,52	,630*	1		
F6: Competent	0,385	0,224	0,079	0,495	0,243	0,497	1	
F7: Positiveness in collaboration	- 0,395	0,491	,677**	0,452	0,498	0,263	0,013	1

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Based on the above descriptive analysis, it seems that children's self-confidence is inextricably linked to the knowledge of the content they are dealing with. This is best explained by the fact that when students could easily manage a new knowledge in STEM, then this boosted their self-confidence and obviously this gave them satisfaction and joy. This conclusion was also found from the above statistical analysis where self-confidence was positively correlated with pleasant work. This seems to be consistent with the findings of other studies which also argue that effective STEM learning presupposes a pleasant engagement of children in such programs (de Jong, T., 2019). The satisfaction of the children was obvious and visible during the workshops, especially in the phase where they had to do the open-project work. At this point there were several children who asked for permission to stay longer in the conference room so that they could continue their work, even if it meant sacrificing time from their rest. In addition, the open-ended work was a unique opportunity for a final assessment of the acquired knowledge and skills, as the children were asked to use everything they learned during the workshops in their

own robotic construction. Field observation also revealed that the summer STEM program was accessible to the middle-aged children who participated in the camp.

8. Conclusions

The findings of the present study showed that children find the summer STEM program enjoyable and easy to use. Field observation also confirmed that students could solve various activities without much help by the trainers whose role was more guiding than teaching. The fact that each group could proceed according to its own capabilities and rhythm, enabled the trainer to allocate his intervention time more fairly and for the benefit of all children. Therefore, groups that did well simply took the instructor's confirmation and proceeded to the next challenge, while where there were children who had difficulty, the instructor had more time to explain and help them. In general, it was also clear that the program was appropriate for the age of the children on the basis of which the program was designed. Both the construction of models and programming seemed to be an easy process for the kids, who really enjoyed it. The gradual increase in children's self-confidence was also observed during the workshops. As the days went by, the children became more and more familiar with the robotic platforms, the approach and the challenges they had to solve and this was evident from the greater comfort with which they could carry out the activities we had. Moreover, the statistically significant correlations between some dimensions prove the importance of taking into consideration of these parameters while designing such programs. It is obvious that aiming of having a selection of pleasantly activities which can easily be achieved by kids lead to the possession of content knowledge that consequently increase their confidence about STEM & ROBOTICS.

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APPENDIX

ANNEX 1

ENGINEO STEM CAMP PROGRAM			
Day/ Time	Morning activity (10:00 - 13:00)	Afternoon activity (16:00 - 18:00)	Night Activity (20:30 - 22:00)
Tuesday	Tour at Engino factory Arriving at Rodon hotel near 12:00 Room allocation	Introduction to STEM Constructions and programming with robotic devices PRO and GINOBOT	Collaboration game “Mystery Box” Programm and camp goals
Wednesday	3D design with software 3D Builder	Advanced programming with PRO robotic controller	Entertainment games
Thursday	Presentation “3D Printing in modern era” Programming with GINOBOT	DIY construction with GINOBOT - “Robo-Fights”	Stargazing with telescope
Friday	Open Project (part 2)	Open Project (part 2) - Presentations	Competition «Engino got talent»
Saturday	9:00 Walk to Agros Village / Tour at rose factory 13:00 Lunch 14:00 Departure		

Table 1. the daily program of the Engino® STEM camp.

ANNEX 2

The questionnaire created on google forms appears in the below link:

<https://docs.google.com/forms/d/e/1FAIpQLScuS0QXcv6v0jPWQIoNPKOuRU7PLWngRzDjvpVKnG9QAYqO2w/viewform>

ANNEX3