STEM Learning and Career Orientation via IoT Hands-on Activities in Secondary Education

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***Abstract*— This work studies the influence of IoT-driven educational activities and tools (software, hardware and educational material) in STEM education as well as their role as STEM related career enablers to young boys and girls. The study builds on previous related results and applies to over 60 young students that are involved in hands-on learning activities in the context of a summer school. The analysis is based on especially designed close-ended and open-ended questionnaires as well as in-class observations and focuses on age and gender aspects. The results confirm the overall positive stance of the students on the educational activities and show that the provided tools under consideration are well accepted and effectively used. Furthermore, students' choices regarding prospective future careers reveal that their views on STEM fields and related professions have significantly been enriched through their participation in the summer school.**

Keywords*— *STEM education, ubiquitous computing, mobile computing, Internet of Things, STEM career

I. Introduction

UMI technologies, i.e., ubiquitous computing, mobile computing and the Internet of Things (IoT) consist the new technological paradigm that is conquering the entire world by allowing "everyware" presence, connectivity to the Internet and computation capabilities to devices other than ordinary computers and smartphones. These technologies prevail more and more in human related activities in all aspects of everyday life, paving the way for young people creativity as well. To be able to actively participate in this new era, in accordance with the values, needs and expectations of the society, schoolchildren need to get in touch, use and understand these technologies. This will boost their willingness to follow a technological career allied with the new era's status. In this context, this paper takes on the viewpoint of IoT technologies emerging both as educational means and learning outcomes as well as a support mechanism for STEM teaching and UMI-STEM related career prospects enrichment of secondary school students.

Several research efforts that introduce IoT technologies into secondary education are available in the recent literature. Stankovic et al. [1] explored how to prepare graduates for a highly cyber-physical world and described how educational institutions should invest to developing, recruiting and retaining the faculty needed to provide an up-to-date STEM education. In [2], a comparison of computer science related STEM curricula of different countries are presented and analyzed. Bojic and Arratia [3] present ways of introducing STEM and IoT fields to primary and secondary students, considering IoT technologies as a useful tool for improving attractiveness of STEM subjects rather than exploiting them as educational means.

Research efforts more closely related with our work include [4] where, a case study is considered over four groups of secondary school students acting as virtual IoT application designers, and [5] which incorporates an IoT-based learning framework into a software engineering embedded system analysis and design course. In a similar to [5] context, Byrne et al. [6] explore the use of a constructivist 21st century learning model by implementing a week-long workshop, delivered as a "hackathon" to encourage pre-university teenagers to pursue STEM oriented careers, with a particular emphasis on computer science. They examined student perceptions and attitudes regarding computer science and found out that their motivation with respect to the design process, programming and IoT/wearable technologies was enhanced. Finally, the Smart Schoolhouse project described in [7] plans to implement IoT related project-based learning over 8 basic and 10 upper secondary schools with over 3,000 students, so that to raise teachers' awareness about teaching STEM subjects and give students the opportunity to use knowledge in diverse areas to solve everyday problems; however, to the best of our knowledge, no evaluation results are yet available.

All the above mentioned research efforts enlighten different aspects of the topic under consideration. However, none of them offer the integrated view of our work. Following the UMI-Sci-Ed project (Exploiting ubiquitous computing mobile computing and the Internet of Things to promote science education) holistic approach, we used a fully developed toolset (an educational collaborative platform, UMI equipment and innovative educational scenarios) enforced by communities of practice (CoPs) that support hands-on activities for aged 14-16 secondary school students. Using UMI technologies both as educational means and learning objectives we aim to make STEM education attractive and effective so as to lead to self-aware future citizens with increased willingness to follow a

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career in UMI fields. These efforts are accompanied by a well-defined evaluation framework that allows us to identify potential drawbacks and enhance STEM educational practice. In this context, a four-day IoT related summer school was held during June 2018, comprising parallel events in four cities with 64 participating students. Extending our previous work [8] on the overall students' stance regarding the activities, collected through close-ended questionnaires, in this paper, we analyze two additional aspects: in what extent students believe that the provided UMI toolset serves well as educational means, and, how the IoT-driven activities improved students' views in following a career in UMI technologies. In this context, student gender and age were set as independent variables and their impact on the above mentioned aspects was evaluated. The evaluation was based on open-ended and close-ended questionnaires as well as observations that took place during the event. The analysis showed that

- The positive stance on the summer school activities that was observed in [8] is cross proved by the students' free text responses. Differentiations in age and gender were confirmed as well.
- Despite the short duration of the intervention, the tools used to support the IoT activities were very well accepted and used by the students.
- A significant enrichment of the student career prospects towards UMI technologies was attained.

The rest of the paper is structured as follows: the next section describes briefly the UMI-Sci-Ed educational tools and methodology. Subsequently, the results and analysis of how students interacted with UMI tools during the summer school are presented together with their STEM orientation and their career considerations. Finally, we conclude with the main contributions of this work and our future research steps.

II. EDUCATIONAL TOOLS AND METHODOLOGY

A. *UMI-Sci-Ed Tools*

Undoubtedly online environments may effectively support the educational process. Previous research works ([9], [10]) have shown that individuals make available pieces of knowledge in online communities so as to interact with other people interested in the same topic and exchange knowledge and experiences. In order to allow and enhance such activities, an open-source based learning environment, the so called "UMI-Sci-Ed platform" (https://umi-sci-ed.cti.gr) has been developed in the context of UMI-Sci-Ed project. The platform provides a collaborative environment in which educational material, projects and artifacts, standard web tools such as fora, blogs, wikis and chat, as well as CoPs are integrated to promote STEM education.

The core elements of the educational approach are the educational scenarios. An educational scenario (ES) is the outcome of an instructional design process that aims at helping teachers to design and develop appropriate activities for learners, by providing all the necessary components a teacher needs, such as the learning objectives, the educational material, the educational activities, etc. Several ESs have been developed during the UMI-Sci-Ed project (e.g., see [4], [8]) by different research teams using inquiry based science education methods that exploit UMI technologies both as learning tools and learning objectives. ESs are used as templates to promote STEM oriented learning experiences following learner-centered approaches which may improve the perception of actively participating students regarding UMI technologies and lead them a vision of a related personal technical career. However, ESs maintain their flexibility and teachers may adapt them according to the needs of the educational setting by creating UMI projects which are specific implementations of an ES.

The UMI toolset is completed with the UDOO-Edu kit, a dedicated hardware kit packed in a handy suitcase that includes all the necessary tools for the implementation of UMI educational activities. The core part is the UDOO Neo board, an all-in-one solution for UMI applications development which may be used as a headless device or as a personal computer offering USB, Ethernet or Wi-Fi connectivity together with a powerful processor and 1 GB of RAM. The kit includes a set of accompanying peripherals, including multiple sensors and actuators. The use of UDOO-Edu kit, under the umbrella of appropriate ESs, enables students to understand, use and develop IoT applications that merge science and technology with their everyday life.

B. *Summer School Setup and Evaluation Methodology*

The UMI summer school took place in four schools in parallel during June 2018. The program included a four day – four hours per day schedule. All four events followed the same ES, entitled "Hands-on… the Internet of Things" that was designed by the CTI researchers with the help of teachers participating in the project. The ES includes a full implementation of an IoT application for smart recycling where, with the use of an ultrasonic sensor and the UDOO board, smart recycling bins send fullness measurements to an IoT cloud [8]. Following an interdisciplinary approach, the ES aims to familiarize students with state-of-the-art IoT technologies, exploiting science (electronic ultrasonic physics), technology (IoT devices, sensors and Arduino programming) engineering (design and implementation of a high-tech application) and math (simple formulas for distance and volume calculation). Founded on problem based, active and collaborative learning [11], the ES aims to engage young students with the UMI technologies and inspire them to follow a career path within this domain.

Sixty four (64) secondary school Greek students, aged 14-16 (25 fourteenths, 16 fifteenths and 20 sixteenths – some did not register their age), fully attended the summer school. The majority of them (45) were boys and none of them had previous experience with IoT hands-on activities. Six (6) experienced secondary school teachers were the main actors of the event with prior knowledge in computing and properly trained in UMI technologies and IoT hands-on experiments. Three electronic/IT engineers as well as three members of the CTI research team were also involved and supported (locally or remotely) the in-class activities, mostly helping teachers and students with the equipment and UMI tools.

A wide range of evaluation data was collected during the event, including close and open-ended questionnaires filled in by students as well as in-class observations. Table I summarizes the questions related to the aspects under consideration. Data evaluation was both quantitative and qualitative to enable triangulation and provide a rich and robust data set. In close-ended questionnaires, the answers were provided in a Likert scale (either 1 to 5 or 1 to 7) where, the minimum means "strongly disagree"/"negative" and the maximum means "strongly agree"/"positive". Texted answers were collected in open-ended questionnaires. The qualitative feedback from the open-ended questions was subjected to a thematic analysis where coding themes were devised [12]. The occurrence of each theme or keyword was counted and this has formed summarization tables (see section III). Observation from one researcher took place in one of the schools involved focusing on the use of UMI tools during hands-on activities. The observation records were analyzed with the open coding method [13]. It should be noted that consent to collect and analyze data for research purpose was given by all students and their parents. Data management and analysis followed the rules of UMI-Sci-Ed project on privacy and security aspects [14].

TABLE I. QUESTION TYPES FOR DATA EVALUATION

Close-ended questions
UMI platform: I think that I would like to use this system frequently. I thought the system was easy to use. I think I DON'T need support from a technician when using the system. I found the various functions in this system were well integrated. I would imagine that most people would learn to use this system very quickly. **UDOO kit:** UDOO is: effective, practical, enjoyable, easy. It is easy to attain skills with UDOO, I intend to use UDOO in the future
Open ended questions
Q1: Write whatever you want for the activity. Q2: How has my participation transformed my view of learning? Q3: What happened and what was my experience of it? Q4: How has my participation changed me? Q5: Which of the following scientific fields are you most interested in (Science, Technology, Engineering, Math, None)? Q6: In which of the following fields would you like to pursue a professional career (Electronics, Programming, Sensors technology, Technical management, IoT applications, None)?

III. Results and Discussion

A. Learning Experience of Students

Taking into account that the students were positively predisposed to attend an event that includes hands-on activities (78% of them were positive in this aspect as was evident by a pre-action survey) the objective to meet their expectations was rather demanding. Naturally, the concept and design of the activities that were integrated in the ES were critical towards this end. As was analyzed through close-ended questionnaires evaluation [8], the overall student satisfaction regarding the summer school activities and their intention to follow similar actions were high. Usefulness and especially enjoyment showed to be rather important to the overall satisfaction, while easiness and ability of students to follow the activities were less critical for girls and higher-aged students. Further analysis revealed that female students were more conservative in their evaluation in comparison with male ones.

TABLE II. ANSWERS IN OPEN-ENDED QUESTIONS

Question 1: 50 answers **"Write whatever you want for the activity"**
Positive stance: 35 students, 70.0% The activities were very interesting/gave me ideas about the future. Activities seemed enjoyable, interactive since we were working together. The event can broaden the horizons of the participants. It was satisfactory but I found it difficult in several places. It was something special. I had never done such activities again. Children interested in programming would like the event. I would like to follow something similar in the future.
Neutral stance: 10 students, 20% I have nothing special to write, I have nothing to say.
Negative stance: 5 students, 10% It will not be necessary
Question 2: 51 answers **"How was my participation transformed my view of learning?"**
Positive Change: 34 students, 66.7% I have learned opportunities and new ways of learning. Learning can be done in a practical way. Learning is not only done by books. Learning is not boring; it can be interesting, entertaining, and creative. Generally changed my view positively. There are learning opportunities through community practice Appropriately, learning was easier. Learning is directly applied to the environment of society.
Neutral Change: 15 students, 29.4% It remained the same - almost the same (fewer answers)
Negative Change: 2 students, 3.9% Everything was very difficult
Question 3: 56 answers **"What happened and what was my experience of it?"**
Positive Stance: 43 students, 78.6% Fun, pleasant, wonderful, experience unforgettable, satisfying, interesting. **I have learned and realized practical applications (Programming, Circuits, Automation, etc.).** I have worked and met other people who are involved with IoT. I learned to cooperate. I learned about IoT and how useful it will be in the future. I learned about new technologies.
Neutral Stance: 11 students, 19.6% I learned to use UDOO.
Negative stance:1 student, 1.8% We dealt with IoT. I did not understand much.
Question 4: 55 answers **"How has my participation changed me?"**
Positive Stance: 37 students, 67.3% I have acquired new skills and knowledge. **It changed my mind about technology.** My horizons in technology have been widened. I met new people and worked together for a common purpose. It made me to understand how technology can improve, change our lives. **It made me think about following STEM jobs in the future.** **My interest in STEM sciences has been increased.** It inspired me to get involved with technology. **The event increased my self-confidence in technology.**
Neutral Stance: 16 students, 29.1% The event has not changed me.
Negative stance: 2 students, 3.6% I only realized how difficult programming is.

In order to further investigate the impact of the ES and its activities on the students, their free texted answers on the open-ended questions of Table I were analyzed and categorized.

Table II summarizes the most frequent responses for the first four open-ended questions (Q1 to Q4) of Table I, by classifying them to "positive", "neutral" and "negative" with respect to the stance that is revealed according to each question's objective. Fig. 1 through Fig. 4 illustrate the corresponding percentage statistics including gender and age analysis as well. In total, the overall stance of the students is very positive (over 66% in all questions). Negative opinions are very limited while the few neutral ones concern responses such as "I have nothing special to write" or "the event did not change me". Many students responded that classroom activities "were very interesting", "learning can be done in a practical way" and "learning was easier". Furthermore, although the third and fourth questions' wording do not ask or predispose students to declare preference in STEM sciences, still their responses include in great extent the opinion that the summer school event helped them to know better the STEM and UMI scientific fields and increase their interest in such sciences. The highlighted responses in Table II reinforce this conclusion. Overall, the results confirm the positive stance that was observed through close-ended questions in [8]. Focusing on the students' gender, it is evident that both boys and girls share a similar positive stance about the IoT activities; the positive view percentages are above 60% in almost all questions. The only exception appears at Q2 regarding the transformation of the students' view of learning (Fig. 2) where girls seem to be more conservative (positive opinions less than 60%) than boys. However in Q4 "How has my participation changed", girls' positive percentage is greater than that of the boys. This is justified by the fact that boys had a more positive stance beforehand for such activities which they still retain.

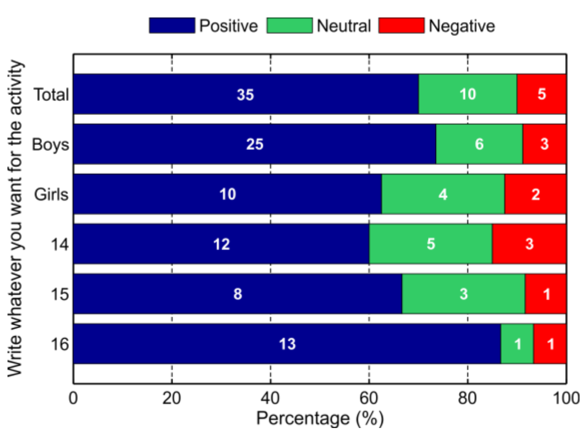

Fig. 1. Results on the question Q1: "Write whatever you want for the activity". Numbers within bars refer to the answers collected.

Considering student ages, the 16ths seem to be more enthusiastic in overall (with an average value of 68% over all questions) but with moderate score in Fig. 2 and a close to neutral stance in Fig. 4, revealing again their already positive thoughts about hands-on activities related to IoT. Similar opinions and scores are shared by the 15ths, although somewhat less positive than the 16ths. On the other hand, the 14ths responded with higher neutral and negative percentages. This fact is consistent with the results of [8] where the opinions of lower aged students, though positive, were more diverted and seemed to be strongly related with their perceived easiness and ability to execute the IoT educational scenario. Overall, this outcome reveals a more "mature" behavior of the 16ths towards UMI technologies and emphasizes that the ESs should be easier to satisfy and engage lower ages as well.

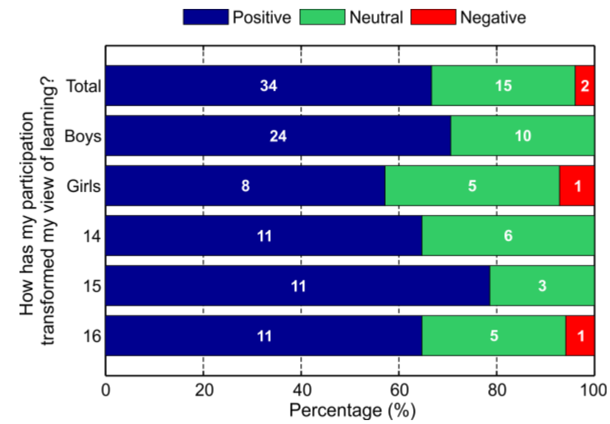

Fig. 2. Results on the question Q2: "How has my participation transformed my view of learning?". Numbers within bars refer to the answers collected.

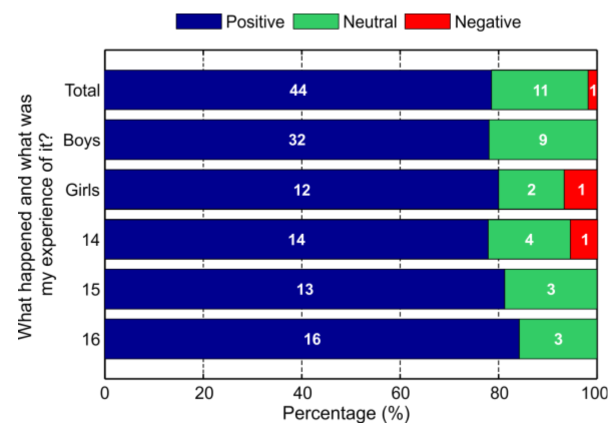

Fig. 3. Results on the question Q3: "What happened and what was my experience of it?". Numbers within bars refer to the answers collected.

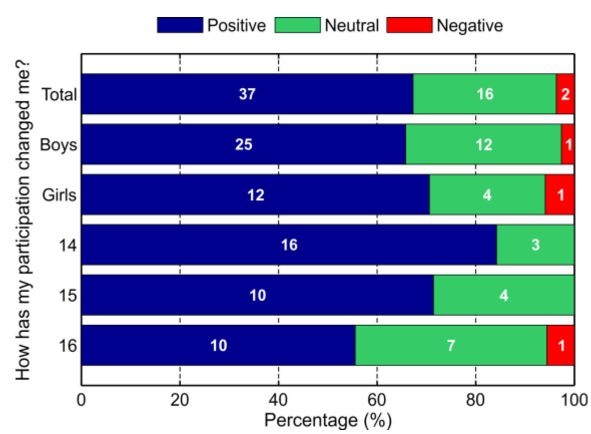

Fig. 4. Results on the question Q4: "How has my participation changed me?". Numbers within bars refer to the answers collected.

Finally, based on the observation analysis, students were enthusiastic about all practical and hands-on activities (thrilled when measuring distance using the sensor). During classroom activities, students worked in groups and collaborated effectively, while day by day they seemed to have more self-confidence and feel more comfortable. Although students without previous experience faced difficulties during the first practical implementations (even in the development of the simple circuit), later on they showed interest and satisfaction, especially when their project worked properly. These students asked for more guidance and explanations from their teacher. It was also observed that boys were usually more confident than girls during discussions about IoT; for example, five boys seemed to have prior knowledge about smart systems, provided additional information during the activities and seemed to be aware of how technology affects contemporary and future professions. On the other hand, two girls stated that they had never done similar activities before, asking for more help.

B. UDOO kit and UMI Platform Evaluation

Fig. 5 and Fig. 6 show the percentage of students' responses (average values over the close-ended questions mentioned in Table I) above and below the median Likert scale values regarding the UDOO kit, and the UMI platform, respectively. Gender and age specific statistics are given as well. The figures illustrate that the students are expressed positively for both tools. In all ages and both genders the answers above the median Likert scale values vary between 60% and 83% (the total percentage is nearly 80%), while the answers below median are relatively low.

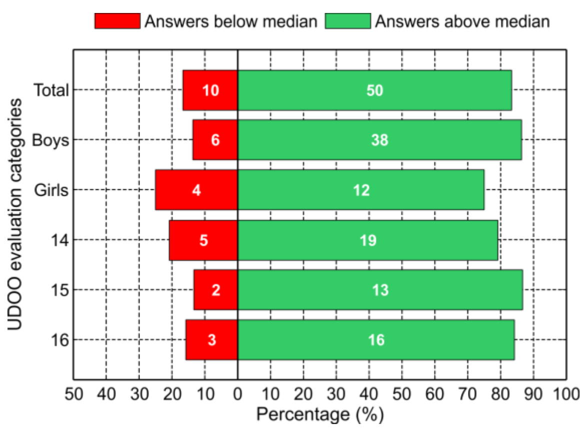

Fig. 5. UDOO kit evaluation by students. Numbers within bars refer to the answers collected.

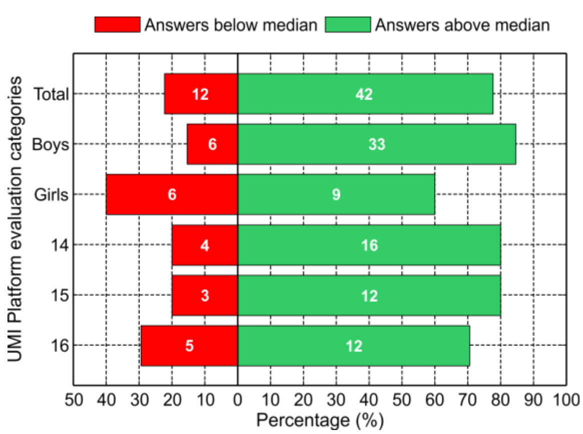

Fig. 6. UMI platform evaluation by students. Numbers within bars refer to the answers collected.

No significant variation with respect to ages can be observed for the UMI platform (Fig. 6). On the other hand, a significant differentiation is noticed between boys and girls (83% to 60% answers above median). Going deeper to the statistics, we found out that in easiness of use evaluation of the platform boys had 19% higher score than girls, showing that boys are more familiarized with online platforms. Moreover, the observation analysis revealed that during the first activity, students were quite skeptical to navigate through the platform, asking for teacher's confirmation. Later on, however, all of them interacted with the platform effectively, especially when they had to use the platform's communication tools (forum discussion, chat) which they seemed to be more confident with. In addition, during the last activity where the students had to use the platform tools in groups, they collaborated successfully in order to formulate and upload their thoughts about IoT and recycling. Finally, they were excited about the capability to exchange their opinions and communicate with students from other cities participating in the summer school.

C. Students' STEM Orientation & UMI Career Prospects

In question 5 (see Table I) students were asked to express their preference on STEM fields. Fig. 7 presents the students' responses including gender information. Clearly, the participating students prefer math and technology. In addition, boys and older students (15ths and 16ths) express their preferences in technology in a greater extent, while girls show less interest in STEM fields other than math. This last observation is aligned with the girls' more conservative stance on IoT activities. Moreover, it can be merely justified by the orientation of secondary education in Greece in math and physics rather than technology and engineering.

Question 6 (see Table I) inquired students to express their willingness to pursue a professional career in pre-selected UMI fields (related to the ES). Multiple choices could be marked. Fig. 8 presents the correlation of their responses with respect to their STEM field preferences. Clearly, programming is strongly related with students who lean towards math or technology while the ones who lean towards engineering or science show a greater dispersion of views. It is also interesting that engineering appears more related to hardware than programming, and technical management more related to math. Additionally, math, besides programming, is associated with many objects, although one would expect to present much more samples in "None", being a basic theoretical discipline. It should also be noticed that there is an important dispersion in career choices, beyond the self-evident career in programming, which is essentially the only "comprehensible" career choice in Greek students of this age, as their educational background in the typical secondary education does not involve many technological or engineering courses. The electronic board design, IoT applications and sensor technology, all new career directions, unknown before the summer school, attracted students a lot, and have been selected even by ones that were expressed themselves as not STEM oriented. Noticeably, electronic board design had a higher overall value than IoT applications (the subject of the summer school). This shows that during the summer school deeper concepts became understandable by the students and drove them to choose UMI related career fields. Overall, the summer school enriched the career prospects of the students towards diverse UMI careers offering them potential knowledge and understanding of IoT technologies and STEM related professions.

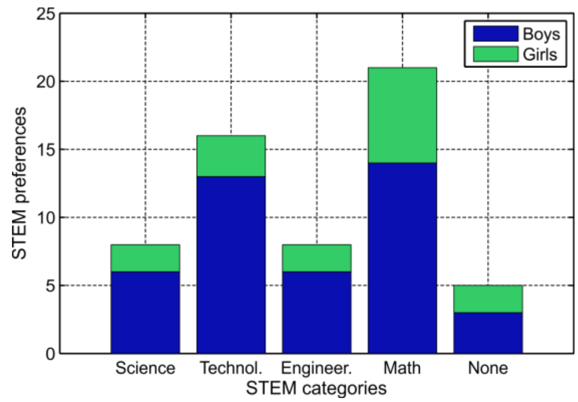

Fig. 7. Students preferences regarding STEM fields.

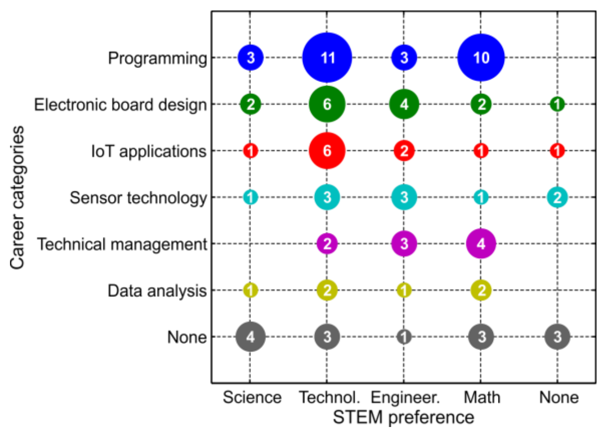

Fig. 8. Career categories chosen by student vs. their STEM field preference.

IV. CONCLUSIONS

The UMI-Sci-Ed approach engages ESs that exploit UMI technologies both as educational means and learning outcomes. Supported by a fully developed collaborative educational platform, a UMI kit for hands-on activities, and CoPs' formation, it aims to engage students in STEM fields and enhance their prospects to follow a technical career. This paper analyzed the results of a summer school, based on IoT hands-on activities. The overall students' stance, their opinions on the provided UMI tools as well as the impact of the activities on views for their future career prospects were evaluated.

Overall, the students' positive stance on the hands-on IoT activities, previously evident by close-ended questionnaires, has been clearly confirmed by texted responses in open-ended questionnaires and in-class observations. The students expressed very positive opinions regarding the UMI learning tools, i.e., the ES and its activities, the UDOO kit and the UMI platform. It is important to mention that the majority of participating students shared a strong belief before the event that hands-on technological classroom activities are beneficial in education, a belief that has been strengthened even more after the UMI event. Students pointed out with high scores that the summer school was very interesting and has widened their knowledge about UMI technologies. Girls provided more conservative opinions in comparison to boys however they seemed to change positively their initial neutral stance in technology. Moreover, older students showed a more mature behavior towards UMI technologies; younger ones related their responses with their ability to use the UMI tools. As a countermeasure, in future interventions, technical activities could be easier so to engage younger students as well. Most importantly, the students showed to understand deeper concepts related to UMI technologies and so expressed their willingness to follow IoT related careers with a plurality and dispersion of choices among almost unknown (before the event) career prospects. In this context, the summer school broadened their technical career prospects.

REFERENCES

[1] J. A. Stankovic, J. W. Sturges and J. Eisenberg, "A 21st Century Cyber-Physical Systems Education", in Computer, vol. 50, no. 12, pp. 82-85, Dec. 2017.

[2] K. T. Delistavrou and A. D. Kameas, "Exploring ways to exploit UMI technologies in STEM education: Comparison of secondary computer science curricula of Greece, Cyprus and England", 2017 IEEE Global Engineering Education Conference (EDUCON), Athens, 2017, pp. 1824-1830.

[3] I. Bojic and J. F. Arratia, "Teaching K-12 students STEM-C related topics through playing and conducting research", 2015 IEEE Frontiers in Education Conference (FIE), El Paso, TX, 2015, pp. 1-8.

[4] A. Mavroudi, M. Divitini, F. Gianni, S. Mora and D. R. Kvittem, "Designing IoT applications in lower secondary schools", 2018 IEEE Global Engineering Education Conference (EDUCON), Tenerife, 2018, pp. 1120-1126.

[5] J. He, Dan Chia-Tien Lo, Y. Xie and J. Lartigue, "Integrating Internet of Things (IoT) into STEM undergraduate education: Case study of a modern technology infused courseware for embedded system course", 2016 IEEE Frontiers in Education Conference (FIE), Erie, PA, USA, 2016, pp. 1-9.

[6] J. R. Byrne, K. O'Sullivan and K. Sullivan, "An IoT and Wearable Technology Hackathon for Promoting Careers in Computer Science", in IEEE Transactions on Education, vol. 60, no. 1, pp. 50-58, Feb. 2017.

[7] M. Kusmin, M. Saar and M. Laanpere, "Smart schoolhouse — designing IoT study kits for project-based learning in STEM subjects", 2018 IEEE Global Engineering Education Conference (EDUCON), Tenerife, 2018, pp. 1514-1517.

[8] D. Glaroudis, A. Iossifides, N. Spyropoulou, and I. D. Zaharakis, "Investigating Secondary Students' Stance on IoT Driven Educational Activities", in Ambient Intelligence, LNCS 11249, A. Kameas and K. Stathis, Eds, Switzerland AG: Springer Nature, 2018, pp. 188-203.

[9] A. Kankanhalli, K. Tan, and K. Wei, "Contributing knowledge to electronic knowledge repositories: An empirical investigation", in MIS Quart, vol. 29, no. 1, Mar. 2005, pp. 113–143.

[10] M. M. Wasko, and S. Faraj, ""It is what one does": Why people participate and help others in electronic communities of practice.", J. Strategic Inform. Systems, vol. 9, no. 2–3, Sep. 2000, pp. 155–173.

[11] J. Good, K. Howland, and L. Thackray, "Problem-based learning spanning real and virtual words: a case study in Second Life", ALT-J, vol. 16, no. 3, pp. 163-172, 2008..

[12] G. Guest, K. M. MacQueen, and E. E. Namey, Applied thematic analysis. USA: Sage Publications, 2011.

[13] A. Strauss, and J. Corbin, Basics of qualitative research: Techniques and procedures for developing grounded theory, California: Sage Publications, 1998.

[14] A. Iossifides, I. D. Zaharakis, V. Stefanis: D1.1–Data Management Plan (v2.0), Public Deliver., H2020 Project UMI-Sci-Ed, No 710583, 2017.