

Response to Reviewer 1

Comment 1. The paper “looks” like project report.

Response.

Our paper is fully consistent with the theme of the special issue. The CFP states: “We solicit original contributions, which report on the development of robotic environments, implementation of educational activities, and evidence-based evaluation of their learning outcomes. Of particular interest are papers in which robotics activities combine design and analysis and involve an exploration of disruptive technologies such as artificial intelligence, Internet of Things, virtual and augmented realities, and 3D printing.”

Comment 2. In the introduction, it would be good to review also some similar models and results of similar student education programs all over the world.

Response.

In Section 1.3 we described models of high school enrichment programs developed in the U.S. and Germany. Following the reviewer’s comment, we searched for other examples of high school enrichment programs and related educational studies. We did not find examples that would significantly add to those already considered in the paper. We added a note that to our knowledge our work is the first educational research of a high school enrichment program focused on learning Industry 4.0 concepts in robotic environments (lines 110-114).

Comment 3. Authors claim to develop students Industry 4.0 skills, but in reality they focus only on some of them. Although they namely mention focus on two main areas - IoT and collaborative sensing, in fact the main focus is on robotics and robotics related disciplines.

Response.

We made revisions in Section 1.4 Purpose statement to make clear that our program introduced high school students to selected concepts and technologies of Industry 4.0 and promoted the development of certain skills (lines 136-148). In the preparatory course the students learned robotics related subjects, while the advanced course focused on project based learning of IoT and collaborative sensing through experimentation in robotic environments.

Comment 4. The data from questionnaires didn't support the topics, as there are only 3 of 5 schools contributed to the IoT and none of them on collaborative sensing?

Response.

In the mid-course questionnaire, the students were asked to self-evaluate the contribution of the preparatory course to learning IoT (Section 4.3). The students from Haifa schools reported on the significant contribution (Table 1 in Section 5.1). The students from the other schools did not learn IoT, as indicated in Table 1. The program evaluation questionnaire asked to self-evaluate the contribution of the whole program to learning IoT. Table 2 in Section 5.1 shows that most students highly evaluated their progress in the subject. The questionnaire requested self-evaluation of the program contribution to learning collaborative sensing not directly. We evaluated this contribution

using the self-evaluations given by the Haifa students for the contribution of the final projects that were focused on collaborative sensing.

Comment 5. Authors are evaluating the increase of interest in presented subjects, but this is quite biased when assuming the schools with technical background. It is not difficult to imagine, that students visiting technical school will have higher affinity to the topics presented in the study.

Response.

In section 4.2 we clarified that the students who joined our program learn in comprehensive high schools where they majored in different technological disciplines and had limited technological background (lines 449-451, 625-626). The subjects studied in the program were new for them, were not part of the school curriculum, and not directly connected to the disciplines they learned. One of the goals of our program was to interest the students in the interdisciplinary concepts and technologies of Industry 4.0.

Comment 6. The paper is missing the attempt to find also some objective measures. All the findings are based purely on student's evaluation of the courses. Is there a chance to measure results at least more objectively -e.g. using some knowledge tests, measuring the time required to solve some problems, or capturing which of the learned skills are really used for problem solving.

Response.

The students from three Haifa schools answered the IoT knowledge questionnaire conducted at the end of the preparatory course (Section 4.3), and its results are reported in Section 5.1. In Section 6 we added a note that we continue the study towards more objective evaluation of the program (lines 709-712).

Comment 7. Data analysis (p. 11) - did you check the distribution? Why you didn't use the paired t-test?

Response.

We extended Section 4.4. Using the Kolmogorov-Smirnov test we checked that the distributions of the students' evaluations are not normal and, therefore, the paired t-test cannot be used (lines 492-505).

Comment 8. Data presentation (p. 14) - adding the corresponding rows and columns to the tables containing the calculated correlations, authors can completely remove the lines 563-579. It is much better to see results in tabular form instead of listing them line by line in the long sentences.

Response.

We edited Section 5.2, more clearly presented the findings related to Pearson correlations and included Table 5 instead of text (lines 594-606).

Comment 9. Some of the citations seems unrelated - e.g. the [29] is not related to the sensor technology importance comparable to ICT, or the [31] is not even mentioning the traffic route planning. For such cases, use the primary sources.

Response.

We formulated the sentence related to the importance of the sensor technology to be consistent with the source, now [31] previously [29]. We replaced the reference on mobile collaborative sensing for traffic route planning by a relevant one, now [33] previously [31].

Comment 10. Nine experiments is too few for the reinforced learning experiment described on lines 277-280. Could you explain?

Response.

To answer this comment, we significantly revised Section 3.2 (lines 279 – 331). We explained in detail that Fig. 3A presents a snapshot of the dashboard made at the beginning of the reinforcement learning experiment, after the first learning trials. We also refined and clarified the text to better describe the dashboards and explain the robot learning and task performance processes – to make it unambiguous and prevent any misunderstanding.

Comment 11. Please, use the age range of your students instead of classes. For those, who are not knowing the school system in your country is information about tenth graders insufficient.

Response.

Done (Section 4.2).

Comment 12. For Education 4.0. please provide an appropriate citation.

Response.

Done (reference [5]).

Comment 13. Line 123 - remove the additional 'the' (the the scaling)

Response.

Corrected.

Comment 14. Line 231 - Tuttlebot -> Turtlebot

Response.

Corrected.

Comment 15. [16] - instead of simple SMART, please use the full title of the mentioned webpage (SMART Robotics Technician Curriculum) and add also a page provider (CMU).

Response.

Done.