LEGO building blocks sets as an experimenting tool in Physics Classroom

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Abstract. The following work concentrates on implementing building block sets in Physics Education in combination with smartphones' applications. The description of the sets and their possibilities are presented. The list of possible implementations in different Physics fields is given based on the available hardware tools. The paper also provides advantages and disadvantages of using aforementioned systems in the classroom. One particular example of activity on visualizing the sound waves propagation is under closer investigation in terms of a pilot project and a series of further experiments is in development stage.

Physics teachers tend to pursue the goal of giving students maximum of the knowledge about the subject. Hence still the most popular way of teaching complex subjects such as physics is lecturing. It is assumed that lecturing helps to give as much information as possible in short time and this is the way it should be done. Even though it is a widely used method, it is not necessarily useful in terms of information comprehension. Following work is aimed to provide possible aid to classical presentation of the information in classroom.

The focus of this work is on secondary school students and older. The accent is put on increasing experimenting time during the lessons by using simple and familiar tools for students. In terms of this research the main tool for interaction with Physics is chosen to be LEGO building block sets; in particular, LEGO Spike and LEGO BricQ were selected. LEGO Spike set includes motors with rotation sensors, color, distance, and force sensors, and a programable block, that communicates between the external devices. The logic of device functioning is written in LEGO programming software – SPIKE App. The program can be written in icon blocks, word blocks, or Phyton.

The research contains a literature reviewing on previous cases of using LEGO in classroom and possible advantages and disadvantages discovered through the experience. Thiciany Matsudo Iwano and her colleagues [1] in their article about the practical experience with LEGO Robotics of a teacher, outline several difficulties connected to technologies in the classroom such as high costs, low suitability for the school environment, and lack of knowledge among teachers about how to use them including in educational process. On the other hand, Isabelle M. L. Souza [2] and her colleagues highlight the fact that LEGO Sets showed their superiority over other robotic kits in several criteria such as modularity level, hardware, curriculum, price, etc. They can be used to explain a wide variety of topics and concepts and helped students to better understand them. However, in the article, it is said that there is no structured research on the implementation of LEGO Sets in Education and there is a potential for research with well-established methodologies and fulfilling statistical analysis. There are even exceptionally creative examples of using LEGO in Physics such as one Sascha Mehlhase [3] describes in his article about building particle detectors out of LEGO bricks. Of course, this is an example of an exclusively demonstration model, but the amount of attention being attracted by such kind of example should not be ignored. Moreover, LEGO sets are very well-known, affordable, and accessible to most schools. Marina Milner-Bolotin [4] in her work on technology-equipped lessons states that they give teachers the opportunity to enlarge the number of concepts that can be examined during the lesson.

Commented [MS1]: It is funny that in one research they mention that LEGO is not ideal for schools because of the high price, while in another research the price of LEGO is considered to be an advantage. :-D

By implementing the curricula containing interactive laboratories and practical work using building block sets, students shall be able to recognize underlying theories and laws of Physics; relate previously learned material with new concepts and practical examples; illustrate studied concepts with a practical possible application; judge and criticize possible solutions and defend chosen approach; design and modify own experimental setting in order to achieve desired outcomes.

Preliminary it was identified that following topics can be covered using LEGO BricQ and LEGO Spike building blocks sets:

- measurements and uncertainties,
- movement,
- energy,
- oscillations and waves,
- light,
- electricity and magnetism.

The implementation of those sets can potentially increase information comprehension levels and attitudes toward science. The sets are affordable and accessible in most locations. They interest people of any age and, used properly, can interest more students in learning science. In order to effectively use presented technologies, I am developing the teaching materials using cognitive science findings and active teaching strategies. To evaluate the efficiency of implementation of LEGO in Educational process, activities will be performed among current students on secondary school level, observed and analyzed. There is already a developed experiment on the topic of waves and sound propagation using ultrasonic sensor. The experiment is at the pilot project stage in cooperation with American high school. I am planning to expand the variety of experiments' topics considered the results of the pilot project.

Commented [MS2]: make it more clear that that's what you're doing

References

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