Identifying Needs of Robotic and Technological Solutions for the Classroom

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***Abstract*—This paper presents preliminary results of the questionnaire (QR) that was conducted during April and May 2018 in three countries: Bulgaria, Greece and Croatia. The QR is part of the activities within project funded by Danube Strategic Project Fund (DSPF): Increasing the well being of the population by RObotic and ICT based iNNovative education (RONNI). The QR has been delivered to schools in each of the participating countries. Two sets of questions were delivered to target groups: teachers/experts and parents. The analysis of the results will be used in proposing innovative teaching strategies and methodologies, transferable across the regions to support effective learning.**

Keywords—robotics, ICT, education

I. INTRODUCTION

The European Parliament resolution on Civil Law Rules on Robotics, which was approved in 2017, clearly emphasizes the belief that robots will exert an even broader and positive role in people's lives and their jobs than it is expected before, using different kind of technological advances such as unmanned aerial vehicles, robots designed to assist in healthcare for the elderly, surgical robots and wearable (cyber physical) systems that can be worn or implanted in the human body. As a consequence of ubiquitous immersion of robots into everyday life, the shared integration between human and robotic capability should be taken into concern, due the robots should not be thought of as human substitutes. And the last but not the least, that declaration draws attention that educational processes have a much more important role than the reflection on the use of robots and/or innovative technology as a teaching tool. The resolution suggests the need for a dual approach to robotics: to train in using robotics on the one hand and, on the other, to examine how robotics can, in association with other digital technologies, support the learning processes. Therefore, attention toward educational robotics grows and current research identified, as it is summarized in [1] that the robotics has an impact on: (i) thinking skills (observation, estimation and manipulation), (ii) science process skills/problem solving approaches (like solution of evaluation, hypothesis generation, hypothesis testing and control of variables), and (iii) social interaction/teamwork skills. These facts are based on the numerous studies such as [2-6].

Considering the above statements as relevant expert opinions, the obstacles to systematic integration of the defined goals can be removed and process accelerated, by those who, in reaching these goals, are directly involved. First of all, those are the teachers who are in charge of the direct implementation of the activities, but also the parents who, with their attitude, can stimulate or prevent the intuitive development of the child.

In this paper, an analysis of a part of the survey is presented to provide an answer on how to introduce innovative technologies into the educational process in different areas within the Alpe-Adria-Danube region, from the perspective of all those who are directly responsible for it, i.e. from the perspective of the teacher and /or professionals who directly participate in the education process, but also the parents, without whom the support and encouragement of the expected results are most often absent.

The main novelty of the proposed approach to identifying current robotic and technological solutions for the classroom is in focusing in parallel on the beliefs of teachers/experts and

parents for possible robotic influences on the cognitive and social child development as well as on policy formation for faster introduction of robotic and IC technologies in the classroom. The justification of this triple view, underlying the designed questionnaire is presented in the related work section.

The paper is divided into five sections. The introduction and related work sections are followed by a description of the structure of the conducted survey in the methods section. The fourth section gives insight to some of the obtained results and the paper ends with the discussion and future work.

II. Related work

Different studies most often test the opinions of either experts [7], students [8] or parents [9], about the role of robotics on the development of individual segments of personality or ability of a student. It is difficult to find a combined approach like the one presented in this paper.

A comprehensive study, based on questionnaire analysis with similar design and inter-item reliability assessment was performed in [10]. It addressed the issue of using social robots in the classroom from the point of view of the teachers, who might find potential for improving the classroom work. The respondents assessed as positive the inclusion of robots in natural science education, but not social sciences or art. One of the assumptions was that providing context might change attitudes. Two pictures were presented of a NAO teacher - with and without a human teacher in the picture. No effect of picture context on the assessments was present, so the answers of both groups were combined. The main outcomes of the study seem inconclusive from our point of view. First, previous research clearly demonstrated that social robots like NAO are best perceived by teachers and children as assistants to the teacher [11]. Children definitely like robots, as evident from pilot studies. But, a comprehensive analysis requires several perspectives on the vision for introducing Robotics and Information Technologies (R&IT) in class.

In [12] a questionnaire on the benefits of using robots at school was delivered to teachers pre- and post- a 2 month study, involving children learning Spanish language in a one-to-one communication with the robot Tega, including 9 sessions. The study compared the pre-study expectations and concerns of the teacher with the post-study evaluation, based on the teacher experience with robots. On the one hand, the pre-study questionnaire revealed higher expectations of the teachers towards the implemented intelligence (cognitive abilities) of the robot. On the other, teachers were surprised by the observation that the robot did not distract from the lesson - on the contrary, helped children focus on the task. Moreover, many of them pointed out that the robot can be very helpful in teaching social skills to children and, also to engage children in groups of 2-3, rather than in individual sessions.

So we decided to look into the direct assessment of teachers and parents opinions on the role of robots as assistants in the classroom, their expectations for helping children acquire social abilities, as well as what policy they find best to implement. The paper presents the initial analysis exemplifying the approach that we adopted in order to design recommendation based on empirical studies and statistical analyses. The entire analysis is under preparation for subsequent publication in detail.

Next, previous work [11] suggested the clear socializing role of robots in class, contrary to the concerns for possible alienation if robots replace teachers [13]. Our approach excludes any possibility for such arrangement, yet we need to get a snapshot of the current opinions about the expected influences of R&IT on both cognitive and social development of pupils.

III. Methods

In order to identify needs and opinions of the stakeholders and interested parties, two questionnaires were prepared. First questionnaire was carried on with the parents of the students from primary school. Questionnaire had four parts: (1) general questions, (2) questions related to the role of Robotics and Information Technologies (R&IT) in cognitive development; (3) questions related to the role of R&IT in social development of children and finally (4) questions related to the Policies. The purpose of questions related to the role of Robotics and Information Technologies (R&IT) in cognitive development was to see how a person (parent) perceive the possibility for bigger involvement of robots and information technologies in developing children's cognitive skills while the purpose of the questions related to the role of R&IT in social development of children was to see how a person (parent) perceive the possibility for bigger involvement of robots and information technologies in teaching children social abilities. There were 36 questions in total. The sections about cognitive and social development in the questionnaire are based on the general psychological theory included in university textbooks [e.g. 14], [15].

Second questionnaire was prepared for the teachers and experts in the field of robotics and informatics technologies. This questionnaire had the same four groups of questions as the questionnaire for the parents but some questions were different because of different type of engagement in education process. There were 38 questions for this group in total.

The questionnaire for teachers was prepared and carried out using Google forms while questionnaire for parents was mainly carried out using paper versions although Google form version was also prepared. Questionnaires were prepared in three languages and conducted during April and May 2018 in Bulgaria (BG), Greece (EL) and Croatia (HR). Also, the questionnaire was conducted in Bosnia and Herzegovina but these results were not included in this paper.

Overall, 184 questionnaires were answered by the teachers and experts (BG – 52, EL – 52, HR – 80) while parents filled 179 questionnaires in total (BG – 29, EL – 28, HR – 122). Majority of questions were Likert-type ranging from 1 (strongly disagree) to 5 (strongly agree). Remaining questions were multiple choice types.

The questionnaires in all 4 languages are given at http://www.ir.bas.bg/RONNI/activity1.html and the respective survey forms at http://www.ir.bas.bg/RONNI/links.html. Both groups - parents and teachers - were from various types of schools (schools located in larger cities, suburban and rural areas).

Here we present our approach to the analysis based on expert assessments in 3 countries from the Denube region with no initial presumptions regarding possible outcomes in each of the country.

IV. RESULTS

Our plan is to use and reuse the questionnaire in future studies. For this reason, validation and reliability assessment of the tool has being implemented on several levels, but for lack of space, here we present mainly our approach based on the methods of face and content validation.

A. Validity and reliability of the questionnaire

The face validity of the questionnaire has been dealt with on a special brain storming session that took place in February 2018 in Kavala, Greece. Before that, the partners in the project distributed the task of designing the questionnaire as follows: The Greek partner designed the questions relating to the cognitive development of children; the Bulgarian - to the social development of children and the Croatian partner - to the formulation of novel policies related to introducing R&IC technologies in schools. In view of the content validity of the final questionnaire, this distribution of tasks was made on the basis of the current and previous research of each partner.

At the brainstorming session, apart from the authors of the questionnaire, experts in special education and pedagogical sciences were also invited to participate in the discussion. Each item was analyzed for being understandable, unambiguous, relevant and readable.

After the session, the set of questions in English were translated in each country native language. Some of the statements were translated back as a check of its content validity. This was also made in view of the reliability of the questionnaire since the aim is to re-use it and compare the results in the future. In addition, one of the questions served as a control to the validity of the instrument. Note: question #8 in the cognitive and social parts of the questionnaire was formulated so, that if respondents tend to give positive answers, to give a negative one and vice versa. The subsequent check revealed that all respondents were sincere in considering the contents of each question and consistent with the shift of context

The responses of the experts in all 3 countries to the first 7 items of the cognitive and social parts of the questionnaire demonstrated high reliability of the instrument, tested as in [16]. The respective values of Cronbach alfa for Croatia (cognitive) and Croatia (social) are 0.83 and 0.87, respectively; for Greece (cognitive) and Greece (social)– 0.83 and 0.92, respectively, and Bulgaria (cognitive) and Bulgaria (social) – 0.86 and 0.73, respectively.

There are all indicators, that the rest of the questionnaire will display similar reliability properties and will be further used and developed by the three participating countries.

B. Questionnaire for teachers and experts

For lack of space, here we present the analysis of responses to 3 cognitive (No 1, 2, 3), 3 social (No 3, 4, 7) and 3 policy related (No 1, 2, 3) questions by the respondents from the three countries – Croatia, Greece and Bulgaria. One way ANOVA on the average scores obtained on each question, revealed significant difference among the experts in the three countries, $F(2, 26) = 13.139$, $p = 0.00014$. This means, that in formulating policies for introduction of R&IT technologies in schools a variety of country specific aspects should be taken into account. Fig. 1 presents some of the similarities and differences, at the current state of the three countries and give ideas for further analyses and studies.

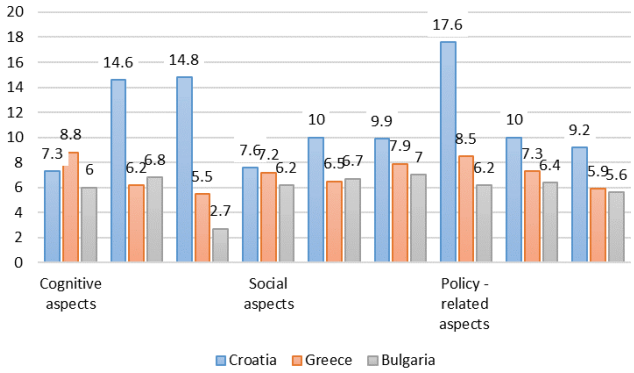

Fig. 1. Differences in expert's attitudes towards introducing novel technologies at school in the different countries.

For example, the teachers in Croatia are the biggest proponents to engage students and older pupils in the process of teaching robotics at school. This can be taken as a model to the other two countries to improve the interactive style at school. Also, experts in Croatia believe more than experts in the other two countries in the role of R&IT education for the formation of mathematical and logical reasoning skills.

It is very interesting to observe that regarding the role of R&IT for the social development of children is similar in all three countries, which suggests in this respect all three can have a common policy.

Answers obtained for the statement "R&IT can support visual orientation and mobility skills" are shown in Fig. 2.

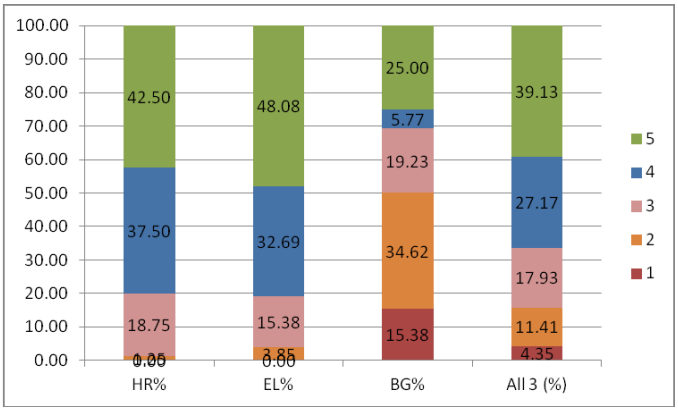

Fig. 2. "R&IT can support visual orientation and mobility skills". 1 - strongly disagree; 5 - strongly agree. Last column represents cumulative results for all three countries. (Part 2, Question #1, QR for teachers and experts).

Similar results were obtained for two other statements related to R&IT support in teaching and learning (Fig. 3).

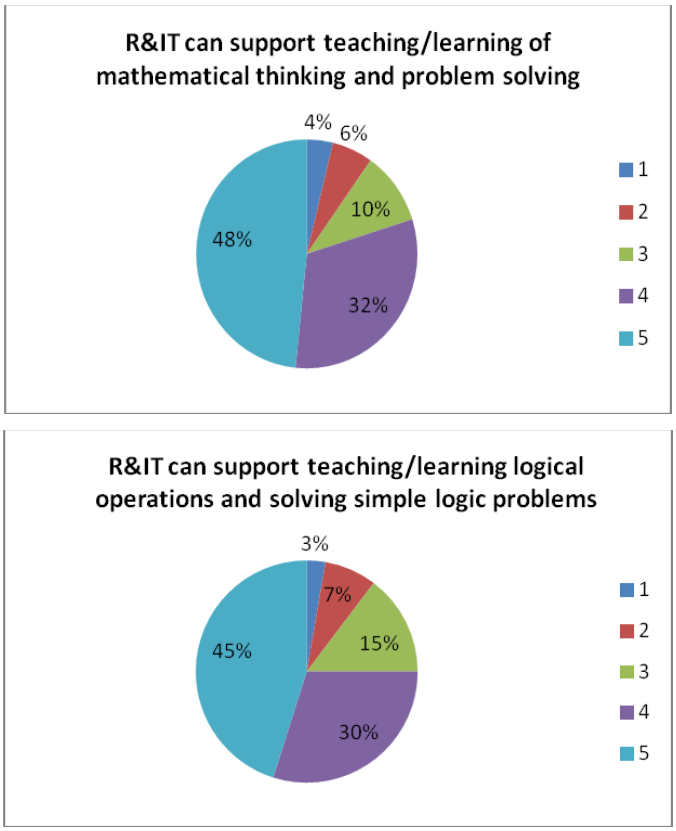

Fig. 3. Cumulative results for Croatia, Bulgaria and Greece. 1 - strongly disagree; 5 - strongly agree. (Part 2, Questions #2 - upper graph and #3 - lower graph, QR for teachers and experts).

It can be seen that majority of answers (75% and 80%) are agree or strongly agree for the questions presented in Fig. 3.

Less optimistic results were obtained for some statements related to the role of R&IT in social development of children. Selected results are given in Fig. 4 - 6.

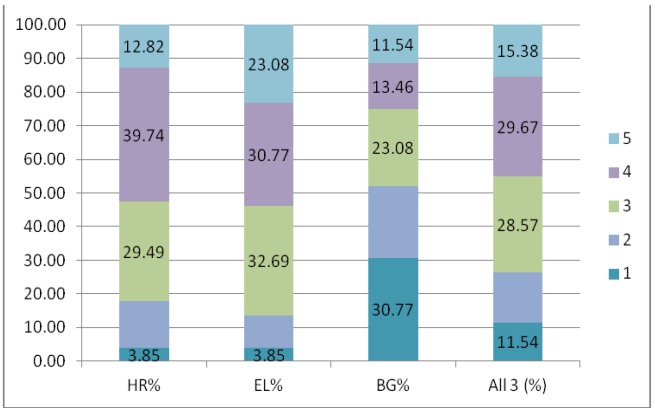

Fig. 4. "R&IT can support teaching/learning conversation skills " (1 - strongly disagree; 5 - strongly agree). Last column represents cumulative results for all three countries. (Part 3, Question #1, QR for teachers and experts).

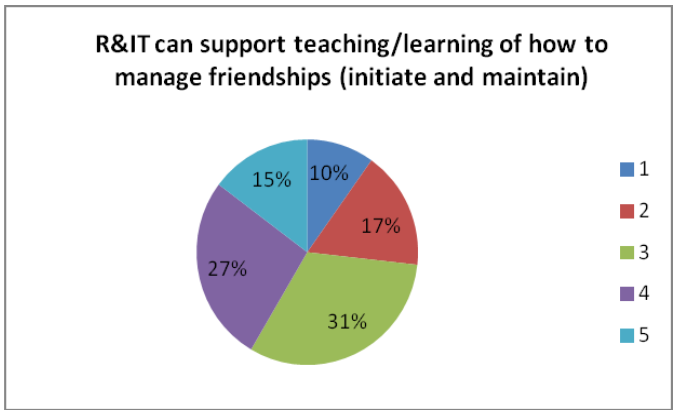

Fig. 5. Cumulative results for Croatia, Bulgaria and Greece 1 - strongly disagree; 5 – strongly agree. (Part 3, Question #3, QR for teachers and experts).

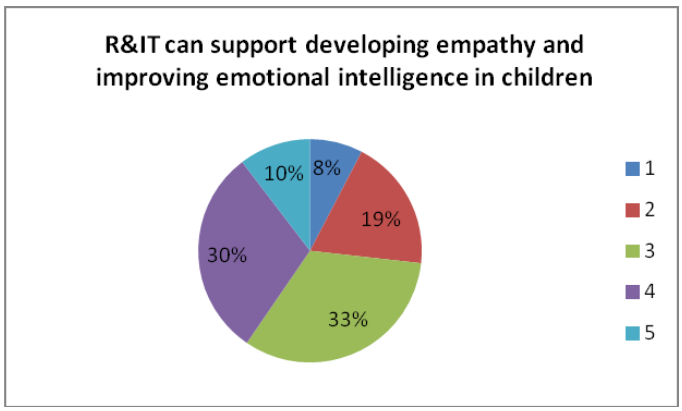

Fig. 6. Cumulative results for Croatia, Bulgaria and Greece 1 - strongly disagree; 5 – strongly agree. (Part 3, Question #4, QR for teachers and experts).

In the Policies part of the questionnaire for teachers and experts some indicative responses were recorded (Fig. 7-10).

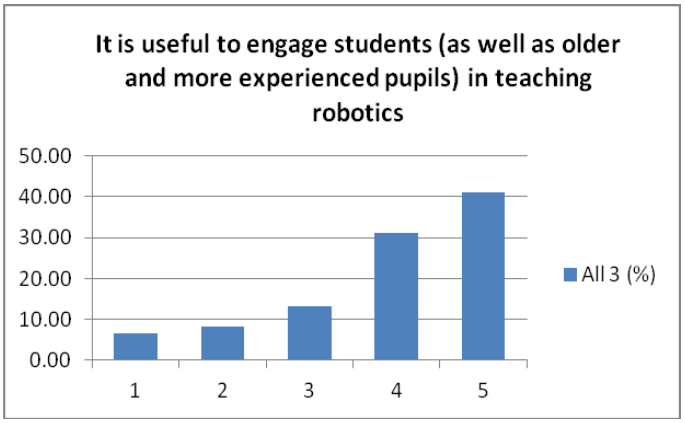

Fig. 7. Cumulative results for Croatia, Bulgaria and Greece 1 - strongly disagree; 5 – strongly agree. (Part 4, Question #1, QR for teachers and experts).

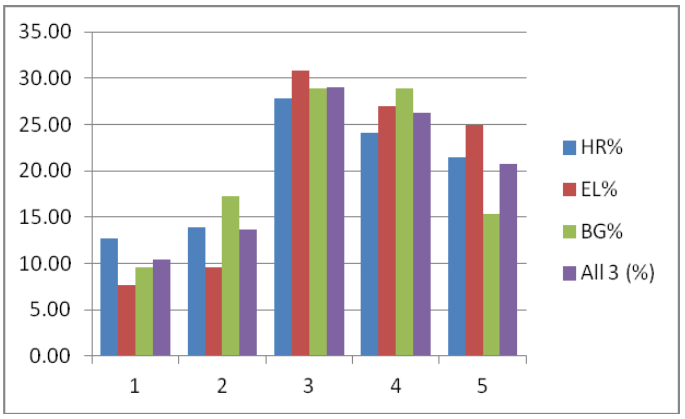

Fig. 8. "Robotics should be a mandatory course at school" (strongly disagree) to 5 (strongly agree). Last column represents cumulative results for all three countries. (Part 4, Question #2, QR for teachers and experts).

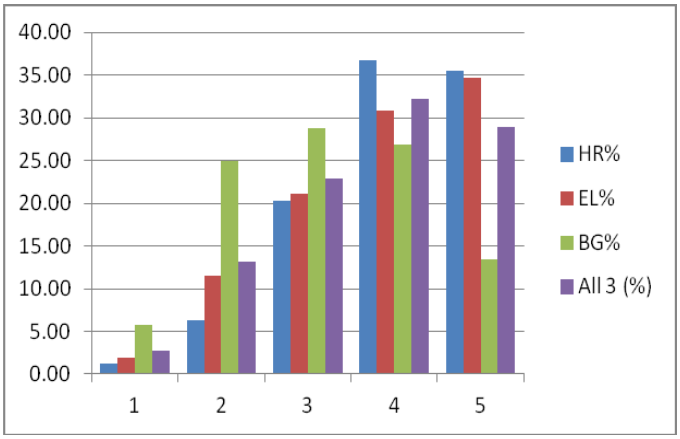

Fig. 9. "R&IT topics should be part of existing mandatory school courses" (strongly disagree) to 5 (strongly agree). Last column represents cumulative results for all three countries. (Part 4, Question #4, QR for teachers and experts).

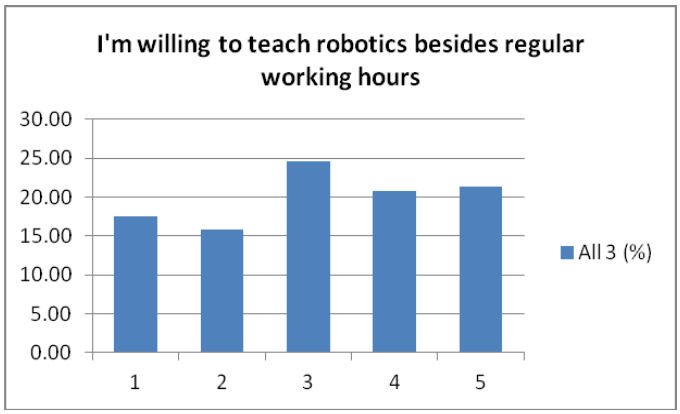

Fig. 10. Cumulative results for Croatia, Bulgaria and Greece 1 - strongly disagree; 5 – strongly agree. (Part 4, Question #7, QR for teachers and experts).

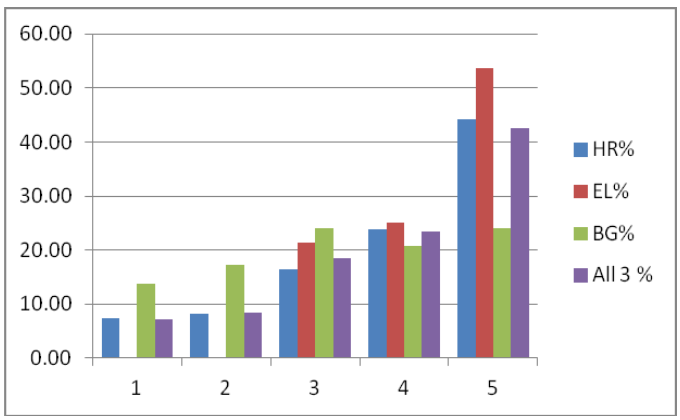

Fig. 11. „It is useful to spend child's spare time for acquiring knowledge in R&IT." Results for Croatia, Bulgaria and Greece 1 - strongly disagree; 5 – strongly agree. (Part 4, Question #4, QR for parents).

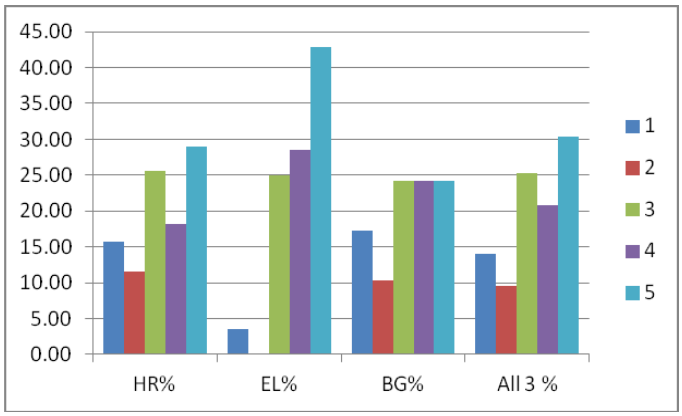

Fig. 12. "Robotics should be a mandatory course at school" (strongly disagree) to 5 (strongly agree). Last column represents cumulative results for all three countries. (Part 4, Question #2, QR for parents).

In addition to presented figures, it should be emphasized that over 67% of teachers and experts think that „Programming courses would benefit from using a robot in the teaching process" (agree or strongly agree). Also, almost 62% think that two school hours weekly is optimal for R&IT

teaching. Finally, more than 71% of the teachers answered that they need additional training in order to teach new R&IT topics in their classes (agree or strongly agree).

C. *Questionnaire for parents*

Parent's attitude can be represented by responses in the Policies section of the questionnaire (Fig. 11-13).

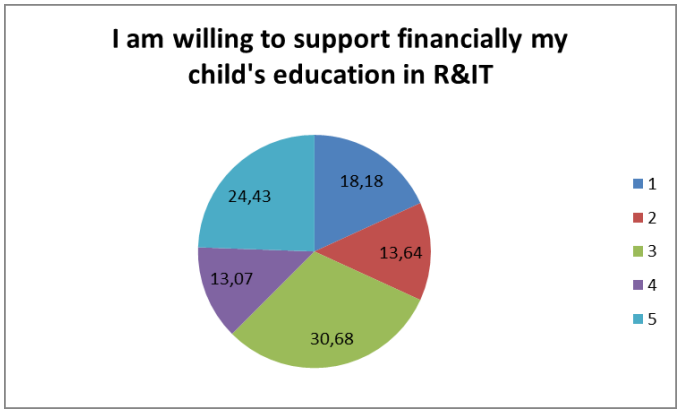

Fig. 13. Cumulative results for Croatia, Bulgaria and Greece 1 - strongly disagree; 5 – strongly agree. (Part 4, Question #7, QR for parents).

V. DISCUSSION

Although thorough statistical analysis and tests of statistical significance were not done (yet), it can be concluded that generally no significant differences were detected between surveyed countries for the most of the answers. There is a issue with different sizes of answers for different countries but complete sample as well as individual samples for each country are big enough to be representative.

Differences on idea of robotics as mandatory course between opinion of the experts/teachers and parents are perhaps smaller than expected although there is no decisive answer overall. There is definitely very positive attitude towards potential of robotics and information technologies as a support in teaching and learning. As it has been already noted in previous section, less optimistic attitude has been reported on the role of R&IT in social development of children. Idea of including older pupils and students into teaching process has been very well accepted. Maybe the most interesting answers are related to the policies because that part is crucial for further strategic decisions regarding successful implementation of new R&IT concepts in schools. As a comment on the obtained results regarding the capability and willingness of the teachers to be a part of new R&IT classes, it seems that additional education of teachers as well as other type of motivation is needed.

We expect that thorough analysis of all the obtained results as well as inclusion of the survey results from Bosnia and Herzegovina could significantly help us in preparation of future project aiming to propose innovative teaching strategies and promoting the application of robotics and information technologies in education.

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