Establishing Effective Teaching for Robotics: a comparison study of Bachelor students participated in Introduction to Robotics course

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Abstract

Global demand in robotics specialists arose necessity of establishing educational programs in robotics, which sets new challenges for modern educational system. In 2017 Kazan Federal University launched master's program in Intelligent Robotics to produce specialists considering core engineering competences and such important skills as self-motivation, critical thinking etc. This paper presents results of continuous survey among undergraduate students of Introduction to Robotics course that helps understanding dynamics of student's motivation to study robotics, attitude toward education methods to improve teaching strategies.

Keywords: Robotics, education, engineering education, master program, motivation.

1. Introduction

Global demand in robotics specialists increases every year as robotics flourishes and integrates into more and more fields of modern economy. Currently higher educational institutions of Russia are facing problems in robotics education: shortage of experts with special education in robotics field, shortage of up-to-date educational materials in Russian, shortage of highly priced equipment etc.[1,2,3] According to study carried out by the HSE Institute for Statistical Studies and Economics of Knowledge (ISSEK), over 60% of Russian employers' organizations in the field of robotics note that they are experiencing a lack of specialists, particularly highly qualified researchers and engineers[4]. Those contradictions between employers' requirements and employees' expertise raise new challenges to prepare effective and highly motivated engineers[5, 6, 7].

Considering the fact that robotics is an interdisciplinary field[8,9] it is our task to develop a multifaceted educational program that would allow students to diversify their educational activity and determine their area of interest. In our previous work we highlighted history and current teaching environment in robotics field in Russia to understand major problems after considering which we developed robotics master's program at Higher Institute of Information Technology and Information Systems (ITIS) of Kazan Federal University (KFU)[1]. In September 2017 our team of Intelligent Robotics Department (IRD) launched a new track in Intelligent Robotics within Software Engineering master's degree program. All robotics courses are taught in English, and the first semester includes such courses as Introduction to Robotics, Introduction to Robotics Operational System and Computer Vision.

In spring 2017, before opening the program, we had conducted several surveys among bachelor students who took Introduction to Robotics course in English to capture drawbacks and receive feedback from students in order to improve teaching methods and course modules[1]. This paper presents results of our continuing research and the rest of it is structured as follows: Section 2 describes research method, Section 3 is focused on analysis and in Section 4 we observe conclusions and future work.

Tatyana Tsoy, Leysan Sabirova, Mikhail Abramsky, Evgeni Magid

2. Research Method

We implemented the same research methodology that we had used in our previous work[1] and provided students with statements and questions on English language comprehension, self-efficiency, active learning strategies, significance of studying robotics, stimulation of learning environment. Eeach item had 5-point scale with optional answers - (1) SD, Strongly Disagree; (2) D, Disagree; (3) NO, No opinion; (4) A, Agree; (5) SA, Strongly Agree – which appear along X-axis in Fig.1-4. Y-axis of Fig.1-4 indicate percentage of respondents that selected the corresponding options. Two surveys were conducted within the same semester: one after the first class (B1) and another after the end of the course (B2). Both surveys were conducted in Russian language to guarantee that all respondents understand the questions. Responses that were received in first survey depict students' attitude towards robotics and expectations from themselves and the course. Results obtained after the course was finished represent the student experience gained during the course. Total number of respondents in the first survey was 37 and in second was 15. To follow the dynamics we selected responds of 9 students, which participated in both surveys, and analyzed the results.

3. Analysis

The comparative analysis covers two check-points during the same semester: after the first class (B1) and after the course was finished (B2). We compared results of survey B1 with results of survey B2.

3.1. *Student English language comprehension*

Considering that Introduction to Robotics class was the first course taught in English for bachelors of ITIS and the fact that 44,4% of students never took robotics related courses in the past, there was positive dynamics in material comprehension in English language in the class. During the course Prof. Magid lectured in English language, however students were allowed to talk, answer questions and ask the lecturer to explain unclear terms and material in Russian. Additionally, no strict English grammar requirements were applied for students when talking or making presentations. Such concessions targeted to minimize limitations for students in course participation, ease material understanding and at the

same time provide them with robotics terms and definitions in English.

The results demonstrate positive dynamics in students' comprehension (Fig.1a) of the material, though we could observe subtle negative dynamics in confidence when students talked in English. There were insignificant fluctuations on the item "I do not want to participate in class because it is conducted in English" (Fig.1b), which demonstrates that for some students in the class English was still a barrier to learn robotics through foreign language. However, studying robotics increased students' motivation to improve their English skills by the end of the course (Fig.1c)
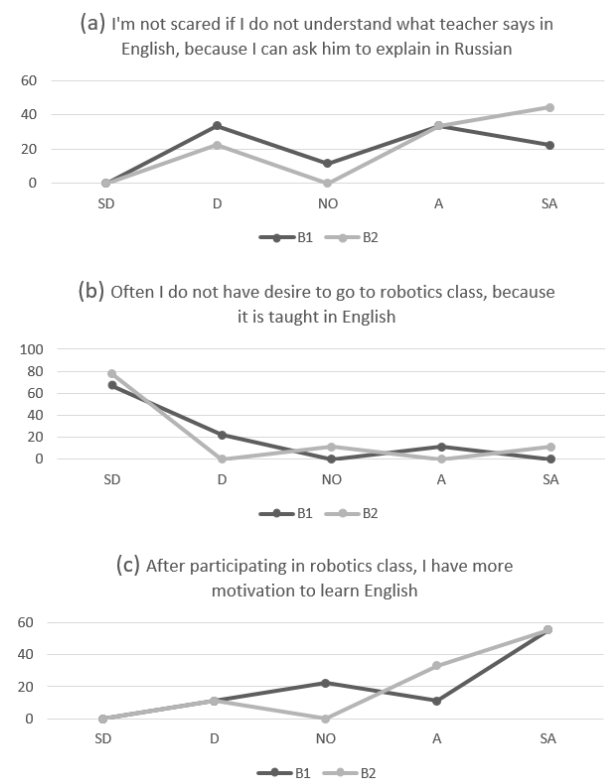

Fig.1 English language comprehension

3.2. *Self-efficiency in studying robotics*

By the end of the course there was no negative change in self-estimation on confidence of studying robotics, yet a number of respondents thought that they could not understand difficult robotics definitions during the class increased (Fig.2a). These results reinforce another graph (Fig.2b), which demonstrates that less students agreed on

the statement that even though a home assignment was difficult, they did not do it; moreover, when home assignments were too difficult for them, they did only easy ones (Fig.2c). The survey showed that by the end of the course the students' applied more efforts in implementing home assignments and in-class tasks.
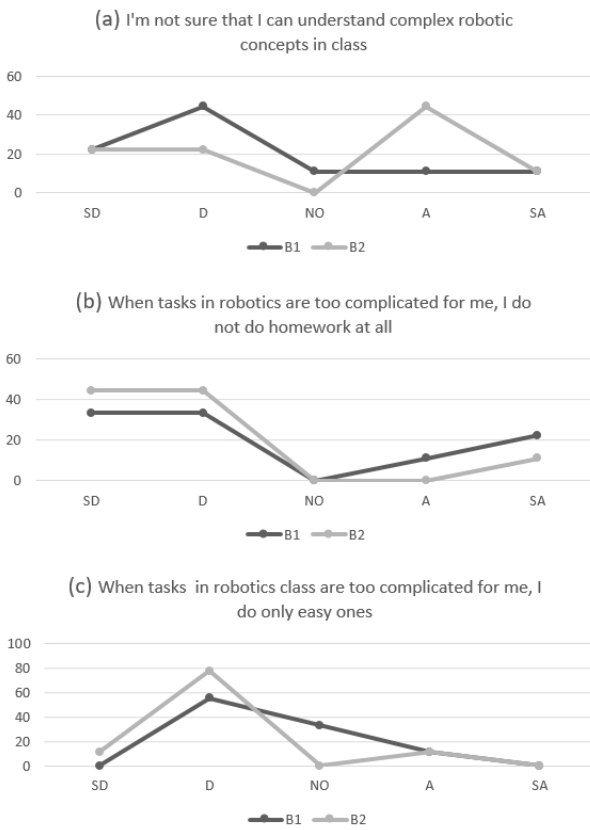

Fig. 2 Student self-efficiency

3.3. *Active learning strategies in studying robotics*

There was more motivation among students to learn material and think on mistakes they had made in home assignments or in-class tasks (Fig.3a), and there was a significant increase in studying complicated concepts when students searched sources by themselves to obtain additional explanations (Fig.3b).
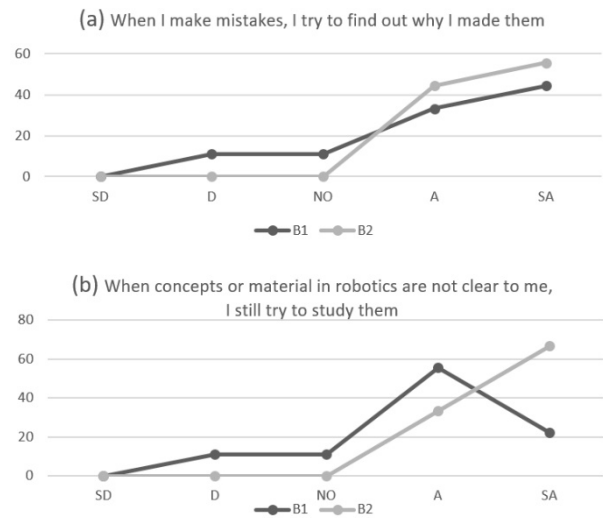

Fig. 3 Active learning strategies

3.4. *Significance of studying robotics*

Unfortunately, there was negative dynamics in thinking on significance of robotics in context of their future occupation (Fig.4a). Additionally, an equal number of students thought that they could and couldn't independently program or model a robot, while by the end of the course the number of those who thought they couldn't - increased by 11,1%. This demonstrate that the students realized the complexity of robotics, which was a positive result of gaining knowledge, and more students confirmed that robotics stimulated their thinking (Fig.4b). Also there was slight positive shift in students thinking that robotics is a team work item "4 – Agree" of 5-point scale increased by 11,1%, and more students by the end of the course started considering robotics to be a multidisciplinary field.

4. Conclusions and future work

The results of comparative analysis showed that by giving students freedom to express their opinion either in English or in Russian, we observed positive dynamics in class content comprehension provided in English by the teacher, although students still felt less confident while speaking English. For a small number of students the class content understanding in English was still a barrier to actively participate in the class. However, for other students the class activities increased motivation (by the

Tatyana Tsoy, Leysan Sabirova, Mikhail Abramsky, Evgeni Magid

(a) I think studying robotics is important, because I will use this knowledge in my future work

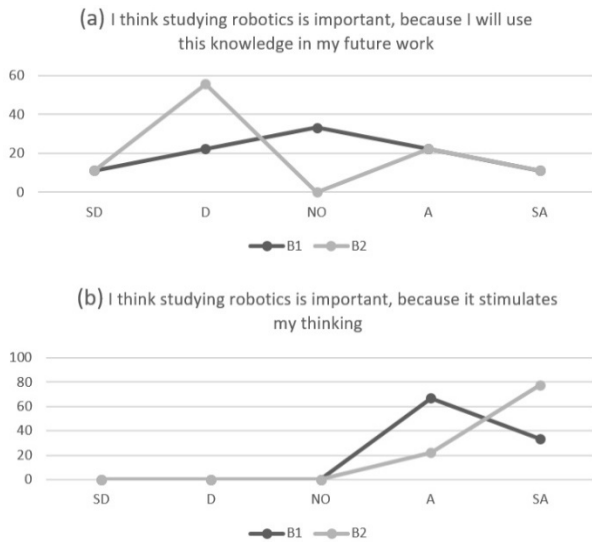(b) I think studying robotics is important, because it stimulates my thinking

Fig.4 Significance of studying robotics

end of the course) to learn English language further. Considering this, we included English language test for master program entrance examinations.

Further self-efficiency in studying robotics overall depicted no major change at the end of the course; however, few issues were discovered that could be related to difficult content of the classes for students. Nonetheless, respondents used more active learning strategies in studying robotics and spent extra time to find additional information that could assist understanding the material. In cooperation with teaching methods and teaching environment (e.g., project work and problem-based learning) robotics stimulated students to apply more efforts in implementing home assignments and in-class tasks during the after-the-class time. As robotics industry is yet not massively developed in Russia comparatively to IT-leading countries and robotics field is not widely highlighted among other engineering fields, most of software engineering bachelor students are still uncertain about robotics bright future and thus did not link their future employment with robotics.

In our future work we plan to pursue our continuous research and observations of student needs to improve teaching methods in order to make it easier for them to understand robotics. Our emphasis is to motivate students in attaining skills required for robotics specialists in

global market. In addition, we have conducted a preliminary research among robotics related companies in Russia on required skills for a young roboticist. Next, to research this topic in depth we plan to develop and launch a large survey among industry and academia representatives in order to analyze and meet labor market requirements by our robotics master program graduates, both in Russia and abroad.

Acknowledgements

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