NAO Robot in School Education: Insights from the European Survey and Design of Teacher Training.

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Abstract. This paper presents findings from a European survey of 849 teachers in Portugal, Poland, Croatia, and Germany, conducted within the "MyRobot MyLearnMate" project. The survey explored teachers' experiences with robots in education, identifying obstacles, motivations, and training needs. Insights from the survey were used to design a teacher training program, following the Design Thinking methodology. We describe the blueprint of the training program with its key modules. The program focuses on the use of the NAO robot as a teaching assistant in schools and will provide teachers with knowledge and good practice examples on how robots such as NAO can be used to innovate teaching and foster inclusive, engaging learning including a wide range of subjects such as mathematics, languages, and computer science.

Keywords: NAO Robot, Humanoid Robots, School Education, Teacher Training.

1. Introduction

School education today faces the critical mission of preparing students for careers and professions, which demand not only an exploration of single subjects and independent work, but rather integration of knowledge from multiple domains and the application in real-world problems [1]. Educational technologies, including robotics, can be used in the classroom to enhance students' learning, foster problem-solving skills, and enhance student engagement to apply knowledge to real-world challenges [1-2]. In the view of harmonious human–machine collaboration, it is crucial to prepare students to design, program, manage and collaborate with intelligent systems for societal well-being, rather than efficiencies only [3]. The Erasmus+ project "My Robot, My LearnMate" seeks to empower both teachers and students to use intelligent systems for societal well-being and sustainability by using the strengths of both human and technology factors [3]. The project focuses on the application of the robot NAO both as a teaching assistant and a didactic tool [4], to support interdisciplinary and inclusive education [5]. Studies have shown that the integration of Educational Robotics (ER) in schools can help in developing essential skills such as computational thinking, problem-solving, decision-making, creativity, and collaborative teamwork [12]. ER may increase students' interest and motivation, foster the learning process [6], enhance students' self-efficacy [2, 7] and support teachers in making lessons more engaging [8]. Therefore, one of the key objectives of the project is to design and deliver a teacher training program on ER in schools to help prepare students for societal and technological challenges in alignment with the EU's Digital Education Action Plan (2021-2027) [9] and the principles of the EU's Green Deal [10]. This paper presents the key results from the survey with 849 teachers from the four European countries (Portugal, Poland, Croatia, Germany) and the design of the teacher training program, which builds on self-reported teachers' experiences, motivations, preferences, benefits and limitations of ER captured by the survey.

2. Study Method

The teacher survey was informed by an extensive literature review on educational technology adoption and ER. The survey included 14 items organised into four sections: (1) demographic characteristics including age, school type and teaching experience, (2) familiarity with, prior experience and prior training in humanoid robots, (3) motivation, perceived benefits and barriers to the adoption of robots in education, and (4) preferences for training materials. The survey employed a combination of single-choice, multiple-choice, rating-scales and open-ended items.

The survey was developed in alignment with definitions and classifications derived from existing literature, including the categorization of robot types and their roles in education [11-13]. Key terms, such as "humanoid robots", were defined based on literature [11] to minimize potential misinterpretations. The survey underwent a pilot testing with a small group of teachers to evaluate usability, detect any redundant or ambiguous items, and confirm the appropriateness of the survey length. Ethical considerations focused on ensuring anonymity and compliance with data protection.

The survey was translated into national languages and shared through national networks. The respondents were teachers from primary (59%), secondary (32%) and higher (9%) education from Portugal, Poland, Croatia and Germany (partner countries in the project). A convenience sampling approach was employed, wherein participating teachers distributed the survey within their professional networks, facilitating further dissemination. This sampling method allowed for a wide distribution, while possibly introducing a self-selection bias. Given a possible overrepresentation of teachers with an interest in educational technologies, the generalisability of our findings is limited, yet of practical value.

3. Survey Results

The study mainly targeted primary and secondary school teachers in Portugal, Poland, Croatia and Germany and investigated the use of ER. A total of 849 responses were collected from teachers in Portugal (n = 333), Croatia (n = 278), Poland (n = 211), and Germany (n = 27). The respondent distribution revealed a gender imbalance, with the majority of female teachers (74.6%, n = 633). This trend aligns with previous findings reported by [14], which indicate a prevalent gender disparity among teachers. Only 25.1 % identified as male, and 0.4% (n = 3) as non-binary. The share of female teachers was high particularly in primary education (46.88%, n = 398). The majority of respondents belonged to Generation X (1965-1980; 60.3%), followed by Millennials (1981-1996; 22.6%). A significant proportion of respondents had an advanced teaching experience of over 10 years (82.7%, n = 702). Most of the respondents were teachers in Humanities (41.34%), followed by STEM (37.34%) and Social Sciences (9.98%). In summary, the respondents were mainly experienced, GenX, female teachers of Humanities and STEM in primary education. Spearman's correlations indicated a sampling imbalance in the distributions of generations ($r = .216$, $p < .001$) and teaching experience ($r = -.277$, $p < .001$) in the survey countries.

One of the key survey results was the predominant lack of guidelines, training and prior experience with ER in all countries. Most teachers reported no experience with robots (59.1%) and no prior use of robots in their schools (58.89%). The vast majority of respondents reported having no prior training in ER (88.34%). 27.33% of respondents classified themselves as "beginners" ("I am familiar with a topic but have no practical experience"), 8.83% as "functional users ("I have used robots in the classroom"), 3.53% as "advanced users" ("I have used robots in the classroom and can assist others in their use"), and only 1.3% as "experts" ("I have used robots and can teach or train others in their use"). Most respondents with prior experience in ER reported that they self-learned about ER as autodidacts by participating in webinars, robotics clubs and talking to colleagues. This informal training/learning was mostly focused on ER such as Lego WeDO, Micro bit, Blue-Bot, Arduino, Lego Mindstorms, EV3 and Spike, and other relevant areas, e.g. AI, programming, computer science.

The study assessed teachers' motivation to use ER, their willingness to participate in ER training, and their predictions of how students would respond to ER in the classroom. These three items were rated using a 5-point Likert scale (1= very weak; 5 = very strong). The results indicate a moderate level of motivation to use ER in teaching ($M = 3.07$, $SD = 1.239$). Teachers' motivation to engage in ER training was higher ($M = 3.29$, $SD = 1.221$), reflecting a generally positive attitude toward professional development in ER. The highest rating was observed in teachers' predictions of how students would respond to ER in the classroom ($M = 4.09$, $SD = 0.889$), which indicates a strong belief among teachers that students would react positively to ER. The comparatively lower motivation scores for using ER and participating in ER training suggest potential barriers and/or uncertainties hindering teachers' readiness for ER implementation.

Indeed, financial constraints were the most significant obstacle across all countries, with Croatia (82.7%) and Germany (81.48%) reporting the highest impact, followed by Portugal (56.4%) and Poland (51.4%). Lack of teacher training was particularly high in Portugal (60.4%) and Croatia (55%), while Germany (59.26%) and Croatia (54.7%) emphasized the need for improved technical support. Low awareness of the potential uses of robots is noted in Germany (51.85%) and Portugal (42.6%). Spearman correlations indicated that school experiences in ER ($r = .249$, $p < .001$), motivation to apply ER in schools ($r = .125$, $p < .001$), and motivation to participate in ER training ($r = .082$, $p = .017$) differed significantly by country, implying that national contexts may influence teachers' readiness to implement ER in the classroom. Prior training in ER was significantly correlated with motivation to use ER ($r = .187$, $p < .001$), experience in using ER ($r = .237$, $p < .001$) and motivation for further training in ER ($r = .192$, $p < .001$). The strongest correlation was between the motivation to use ER and motivation for ER training ($r = .847$, $p < .001$). Moreover, both the motivation to use ER ($r = .522$, $p < .001$) and the motivation for ER training ($r = .525$, $p < .001$) were significantly correlated with positive predictions of how students would react to ER.

When asked about their preferred type of training materials, the respondents from all countries prioritised step-by-step lesson plans. Case studies and best practice examples emerged as highly valued resources, particularly in Croatia (66.9%) and Germany (48.15%), suggesting a strong interest in learning from real-world applications and successful implementations. Video tutorials were preferred by a majority of respondents in Croatia (57.2%) and Portugal (53.7%), highlighting the demand for guidance that facilitates independent learning. Additionally, ready-to-use activities for students were most appreciated in Germany (62.96%), reflecting a preference for hands-on, easily deployable resources that can be directly integrated into classroom settings. These findings underscore the importance of offering a diverse range of material types that cater to different needs and preferences.

Finally, answers to open survey questions revealed that ER training was perceived by teachers as an essential factor for overcoming barriers and increasing ER adoption.

4. Design of the Teacher Training Program

Based on the survey results, the teacher training program was designed following the Design Thinking (DT) methodology [15]. This iterative and collaborative approach aimed to utilize the results of the survey to create a user-centered training plan that equips teachers with the necessary skills to effectively integrate the robot NAO in their classes. DT was integrated with the survey requirements by applying selected DT tools [15] to support the design process.

4.1. Step 1: Co-Creation Activity

The design process was initiated through a co-creation activity structured into six key stages of DT: empathy, define, ideate, prototype, and test [15]. The activity included interactive sessions with project partners designed to gather insights, define training goals, and develop training module prototypes. In the “Empathy” stage, teachers' requirements were explored through empathy mapping [16], which helped to understand diverse needs, expectations, pains and gains. The “Define” stage focused on identifying and prioritizing key goals for the training, ensuring alignment with requirements. In the “Ideate” stage, brainstorming techniques were used to generate ideas for training modules. The “Prototype” stage involved small working groups developing training module blueprints, outlining objectives, content, and instructional methods. In the final “Test” stage, the proposed training modules were presented to peers, and feedback was gathered. The outcomes built a foundation for the design.

4.2. Step 2: Course Structure and Module Design

The outcomes of the co-creation activity guided the design of the three modules in the training program, emphasizing the need for the training to be short, easy to follow, and engaging. To ensure accessibility and account for the limited time teachers have for training, the program was structured into three modules. The first module provides a general introduction to ER, covering essential topics such as benefits, challenges, and ethical considerations. The second module focuses on the technical aspects of working with NAO, offering training in Choregraphe, programming fundamentals, and troubleshooting common technical challenges. The third module provides didactical guidelines and practical lesson plans tailored for various educational domains, including computer science, mathematics, and language learning. Each module was designed to equip teachers with the knowledge and skills needed for ER.

The modules were integrated into the LMS Moodle and the training will be delivered through the LMS Moodle in 2025, which is a familiar and accessible learning environment. The training content was designed to support an engaging and self-paced learning and encompasses a range of different material types, such as texts, self-assessments, videos and gamification elements. A gamified approach incorporates progress badges to enhance motivation to continue the course, while the final badge recognises achievement in the form of a digital certificate aligned with the ESCO framework, https://esco.ec.europa.eu. In the final stage, the training program will be translated into national languages to enhance wide use in participating countries.

4.3. **Step 3: Constructive Alignment with Blueprint Design**

The BDP (Balanced Design Planning) tool, https://learning-design.eu/en/index, was applied to support the development of the three training modules. BDP follows the principles of constructive alignment [17], which focuses on aligning learning outcomes with teaching/learning activities and assessment. Using the BDP tool, the design of the training modules was aligned on two levels: (a) vertical alignment of learning outcomes with the European Qualifications Framework (EQF), and (b) horizontal alignment of learning outcomes with teaching/learning activities and assessments. The BDP tool was used to support the workload and resource planning by considering both learner and teacher workloads in all steps of the learning pathway. The implementation of the BDP tool followed a three-step process. In the “Planning” phase, the course details and the learning outcomes were defined. In the “Creation” phase, topics, units, and teaching/learning activities were added to align with the learning outcomes. Finally, in the “Analysis” phase, the course design was reviewed, and adjustments were made. This enabled project partners to start the creative process of content design in one environment of the BDP tool.

5. Conclusions

The findings from the survey with 849 teachers in 4 European countries conducted in the project "MyRobot, MyLearnMate" highlight several critical insights into teachers’ experiences, barriers and motivations in relation to ER. These served as a foundation for the development and deployment of the ER teacher training program. The data revealed limited experience with ER, lack of training and support, financial barriers but also motivation for ER training in all participating countries. The results suggest that teachers with prior ER training have a stronger motivation to use ER and participate in ER training, which underscores the need for training opportunities. The forthcoming training program will focus on providing accessible, cost-effective, and flexible learning solutions in the form of self-paced online courses with three modules and a certification pathway, to enhance motivation and recognise achievements.

Moving forward, our key efforts will include translating training materials into national languages to ensure wide reach, as well as continuously gathering feedback from participants to refine and improve the program. Additionally, strategies will be implemented to raise awareness of the training opportunities in ER and encourage broader participation through targeted outreach and dissemination activities. By addressing the barriers to the adoption of ER captured by our survey and leveraging the identified motivational factors, the "MyRobot MyLearnMate" project aims to foster integration of robots in school education and equip teachers with the skills and confidence needed to embrace humanoid robots as part of Educational Robotics (ER).

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