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Robots in future-ready schools. Case study: Robot Pepper at Primary School Savremena

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Abstract: Machine learning will be a component of the future learning environment. Robots may provide integrated knowledge to elementary, high school, and college or university students by merging human learning components with robotics. For example, teachers can use humanoid robots to converse with students remotely, which is considered a step above telepresence. A teacher can remotely attend a class through a display in this example.

Currently, classrooms use robots to assist teachers rather than entirely replace them. However, colleges and universities will use robots instead of instructors in the future. The voice recognition software on the robots helps them understand what their human counterparts are saying. This increases the reading and understanding abilities of robots. Robot instructors are also equipped with projectors, which allow them to convey things in an entertaining way, piquing student interest.

Social robots and educational robots may be employed to train students soon, but at the present time, they are in use only in future-ready schools. We will present one such school through a case study.

Keywords: robots in education, STEM, Pepper robot

Introduction

Many schools and institutions worldwide are already using some tips robots in the classroom. We are witnessing rapid technological advancements. This progress is due to the process of digitalisation. There are different types of robots used in education and they all have different functionality. (Alnajjar et al, 2021). Those complex robots can only be found in future-ready classrooms.

While educational robotics has already been used worldwide in different fields for a long time, more complex and humanoid robots are expanding at a fast pace and pedagogical experts are still exploring their potential in various school-related activities. Artificial intelligence is still very much an unknown concept to many teachers, which emerges in debates and discussions related to its assistance to teachers and students.

Even though the impact of educational robotics in education is still an ongoing subject of interest and research, conducted research and trials show more and more creative and effective use of robotics in education and student development. Robots are not only used in STEM education. With technological advancements and practical solutions, despite technological and economical challenges, robots have found their way to many classrooms worldwide – not just STEM labs. Many schools have even recognised the impact of humanoid social robots and artificial intelligence on the social and cognitive development of children (Belpaeme, 2018).

Apart from critical thinking and soft skills, many pedagogical methodologies are more and more focused on the development of computational thinking as one of the main students' competencies in 21st-century education (Tengler et al, 2021). Researchers have emphasised that computational thinking is considered to be an important skill that is not only limited to computer science education but is also represented in different fields and in everyday life (Grover; Pea, 2018).

Tengler et al. evaluated the impact of programmable and inexpensive robots in education, merged with a didactic design that involved 45 third and fourth-grade students. The data collected has shown a suggestive increase in computational thinking skills in both third and fourth-grade students in a case study involving robotics in storytelling methods (Tengler et al, 2021).

Cortiana and Rigotto have also shown in their research that primary school students can improve their communication and socio-emotional skills by using educational robots in their literature studies.

The results collected confirmed that the use of educational robotics can indicate an empathic approach to the literary text. In fact, when children use educational robots by moving and programming them according to the story, they show a better and deeper understanding of the characters, behaviours, and actions (Cortiana; Rigotto, 2019).

The benefits of interactive and participative learning have also been demonstrated in humanoid robot tests in schools, in teaching and learning of second language (Chang, 2010), while Encarnação et al. emphasise the importance of robotics in adopting different cognitive abilities due to innovative platform for creative and engaging learning opportunities (Encarnação et al. 2014).

As part of its secondary research, the work analyses a case study of the development and use of the robot Pepper in Primary School Savremena.

Educational robots

The phrase "educational robotics" refers to an area of research that strives to improve student learning experiences by developing and implementing robot-related activities, technologies, and virtual objects. In practise, these activities may require the usage of a physical robot, which might be a modular system like LEGO Mindstorms or robots designed expressly for the tasks at hand.

Design, programming, application, or experimentation with robots may be envisioned for students from primary through graduate levels. Educational robotics activities often involve using a robotics kit with which students learn how to build and programme robots to perform a particular purposeful activity (Jung & Won, 2018). These activities might include interventions, after-school programmes, volunteer classes, or a whole robotics course module.

Robotics kits give a modular approach to programming and constructing and are frequently utilised as creativity-enhancing interventions in the classroom. Working with these kits allows students to use engineering skills and creative solutions to various challenges, beginning with moving a robot from point A to point B. Furthermore, problem-based learning and gamification approaches are directing the adoption of educational robotics interventions. Gamification refers to applying game features in non-game circumstances to increase motivation (Sailer et al., 2014).

The natural form of the robots may increase student engagement (Zawieska et al., 2015). The properties of robotic devices themselves can also provide intriguing results. Apiola et al. (2010) discovered that the fun component of robotics and the physical embodiment of learning materials had a crucial impact on students' engagement in interviews with students who took a course that included the usage of robots. Nemiro et al. (2017) stressed the relevance of robotics in establishing an engaging classroom environment in exploratory qualitative research.

Robots would save time and help students to obtain academic achievements

Many teachers argue against the efficiency of robots. Even if they answer questions faster than a teacher, their responses may not be as precise. But this is a myth promoted by people who oppose technological development. Robots will be more efficient and quicker at tasks and answering student enquiries. The robot's artificial intelligence will also make several customised judgements depending on student feedback.

Robots might even adjust the entire learning experience to each student's personality. A robot can accomplish this automatically, but teachers must spend time researching and establishing the optimum learning environment. Robots can recognise students' skills and flaws and help them overcome them.

There are not enough instructors in many schools around the world. Some institutions cannot afford to pay competitive rates, but they might be able to afford instructors until robots are socially connected. Robots would be fantastic at grading students and helping them achieve their individual goals in the future. Contrary to popular belief, robots do not disturb the educational process. Robots will become more advanced as artificial intelligence advances. Besides immediate access to any materials and knowledge base, there are many more advantages.

In the near future, robots will be an essential part of education in developed and developing countries due to the benefits they provide. Nowadays, it is not often that we can see a humanoid robot in the classroom.

Various sorts of robots can assist human learners in acquiring or deepening knowledge and abilities. Robots can assist in the teaching of a variety of subjects, including geography and history. It is common practise to use robots to teach STEM disciplines including computer programming.

Can robots educate future tutors?

Using social robots to educate future teachers about digital concerns has recently been expanded to secondary and university teacher education. The European project Embodied Perceptive Tutors for Empathy-based Learning investigated how a robot could assist secondary school pupils. Significant effort has gone into developing artificial tutors with human capabilities, intending to increase the efficiency attained by a human teacher. Nonetheless, these systems lack the personal, empathetic, and human characteristics that distinguish a conventional instructor and fail to engage and motivate pupils in the same manner that a human teacher does. EMOTE (EMbOdied-perceptive Tutors for Empathy-based Learning), an EU-funded initiative, was planned in order to design, create and test a new generation of virtual and robotic embodied teachers with perceptive capacities capable of engaging in empathetic interactions with learners in a shared physical area.

Case Study: Robot Pepper at Primary School Savremena

The Pepper robot is characterised by the ability to communicate through voice commands and interpret them. Also, Pepper is capable of reacting to human emotions. It quickly detects joy, sadness, anger, or surprise and responds with an appropriate reaction. Pepper has 2D and 3D HD cameras, which allow it to see objects, faces, and the emotional states of individuals around it with great precision. It is a multipurpose social robot that empathises with humans. Depending on the application, Pepper can be utilised in various ways. Pepper can communicate with people in real time by talking, listening, gesticulating, dancing, and interacting with them.

Pepper establishes emotional relationships with its humanoid look, gesture detection, and response, using human voice and behaviour. The RMS (Robot Management System), along with proactive discussions, gives the robot a livelier, more informative appearance.

Pepper's characteristics include the following:

» Interactions are emotionally charged;
» Proactivity;
» Perception of the user;
» Environmental perception;
» User identification and memory;
» Zones of interaction (distance recognition);
» Conversational advice;
» Voice, touch, and gesture interaction.

Although Pepper cannot be used as a stand-alone teacher, as a teaching assistant, it fulfils all requirements. It can be used as an inexhaustible source of information that it tries to present in a relevant context, like Siri or Alexa. Also, because of the screen that the robot has on it, it can test the individual. Also, the robot can be used as an advisor during the student's learning.

Pepper is intended to operate successfully with students of all ages. It can provide tailored advice and response to each student during the teaching process, assist them in searching for the proper material to help them complete tasks, and interact with one person or a large team, which makes it incredibly effective in all sorts of training.

At Primary School Savremena, Pepper is a new team member. Savremena is the first (and only) school to deploy a genuine humanoid robot in the classroom, which understands human emotions, enhances teaching, and assists students in acquiring STEM information in a fun, engaging, and efficient manner. What appeared to be a faraway future until recently has now become a lovely reality for Savremena's students. The robot Pepper has an almost supernatural capacity to understand human emotions. Pepper's powerful AI allows it to analyse facial expressions and human speech tones, allowing it to interact with people, assist them in their everyday tasks, and share its knowledge with them.

Thanks to additional software solutions, biometric processing of photos were enabled, which is why Pepper has the ability to recognise faces and initiate communications, which encourages the engagement of students and their involvement as active participants in the teaching process.

Students and teachers enjoy the company of our friendly robot and they greatly appreciate the amazing experience its presence provides. In other words, Pepper makes a great contribution in the classroom, thanks to which every school lesson turns into a learning holiday. In addition, the robot Pepper is a dedicated assistant to our teachers and greatly helps them in improving their work methods.

Bearing in mind that teachers at school already have the obligation to prepare for class, Pepper does not pose an additional obligation for teachers in any way. On the contrary, based on simple lessons in the form of text scenarios, teachers are able to prepare an effective and creative lesson very quickly, and using applications and a browser on Pepper's tablet, they can improve their lesson at any moment.

By introducing Pepper into the classroom, a significant impact on student engagement and participation was observed. Students actively participated in English, mathematics, computer science, and biology classes by asking questions in order to get answers from Pepper. The teachers particularly emphasised Pepper's impact on the retention of knowledge among students who covered the learning material in the classes where Pepper took on the role of a teaching assistant.

In addition to the academic development of the students, Pepper's influence was particularly evident as a pedagogical measure for students of lower grades (7–10 years old) because the students were significantly calmer and more engaged in classes with Pepper, while the installed phonometer in the classrooms showed lower levels of inarticulate noise.

The practical part of the classes held:

At Primary School Savremena, robot Pepper managed to implement and show a practical example of how the concept of an already established curriculum and daily lesson delivery can be changed into something completely different with fascinating results.

Using the STEM system and artificial intelligence, Pepper introduces us to innovations in real-time, introducing new methods, leading students to participate in class using their intelligence, knowledge, and curiosity to draw conclusions and ask questions based on the covered material, connecting new facts that they just learnt, eager for more information.

If we consider it from the teacher's point of view, Pepper is their assistant who gives them the opportunity to explore the material they already know well, but in a completely different and more interesting way, and the very presence of Pepper in the class and its influence on the students is reflected positively in understanding the class material, which is an additional plus in for the outcome of those classes and that subject. From the pedagogical side, we have positive feedback, because even the students who misbehave the most want to be in the presence of Pepper, and their engagement in that class is automatically encouraged when Pepper enters the classroom.

From the students' point of view, they are more interested in the material of any subject when Pepper is in class, and they memorise more intensively what Pepper says, as well as Pepper's answers to their questions. Pepper also offers interactive quizzes and different ideas for checking acquired knowledge. Everything is carefully designed and students are motivated to compete and solve the tasks with Pepper. Students pay more attention in class, and they are concentrated and disciplined.

One important thing was observed that can be used to further investigate Pepper's use in teaching, which is that students have a desire to know what Pepper will teach them next in order to prepare for a certain lesson and be ready to ask him "difficult" questions.

Let's assume that in that case the students come to the class with prior knowledge of the new planned teaching unit and have found all the information they could find. In that case, Pepper goes a few steps ahead of them and ahead of the planned material, and Pepper will easily make those steps using its artificial intelligence.

However, at that moment, a completely new dimension opens up in the approach to learning, mastering the material, acquiring knowledge, recognising interest in certain areas, and connecting with everyday activities, but in a way that is completely individual and proportional to the level of information and interest of the student standing in front of Pepper, because there won't be a limit and students will be given complete freedom to connect the subject they are studying with anything from the real world and get new information and data that can take them to prehistoric times or to another planet within seconds.

Conclusion

Although the use of educational robots is currently only a privilege of the best schools, in the future it will become part of our everyday life.

Everything so far indicates that the robot Pepper has a huge potential for use in teaching, that its application so far through a practical example in our Primary School Savremena leads to the conclusion that teachers, students, and the educational system in general can, with Pepper's involvement in teaching, create a completely new and better approach to teaching and learning.

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