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Hands-on project driven approach for teaching non-robotics major students robot design technology

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Abstract: This research paper explores effective teaching methods for non-robotics major students to acquire knowledge and skills in robot design technology. With the increasing integration of robots in various industries, it is essential to provide students from diverse academic backgrounds with opportunities to learn about robot design. The paper examines existing literature on teaching methodologies to identify best practices. The findings suggest that hands-on project driven methods combined with interdisciplinary approaches and student-centered learning can enhance the learning experience and promote engagement and retention in robot design technology. The paper also discusses the importance of incorporating real-world applications, collaborative learning, and assessment strategies tailored to the needs of non-robotics major students. Overall, this research aims at providing educators with valuable insights into effective teaching methods to facilitate the learning of robot design technology among non-robotics major students.

1. Introduction

The demand for robotics knowledge and use has been on the rise in today's life and recent years. There has been a big challenge with non-robotics major student getting none or little knowledge about robotics due to inefficient teaching methods. It is because of this need that we did research with focus on providing students with the training using hands on project approach method, insight and tools to approach this situation holistically. In the past, Robotics education is seen to be only available for the privileged ones who had a specialized program or course within their school. Yet, and there is a growing awareness that the role of robots in the economy is not simple anymore. The education should be offered to students who represent different academic origin, ranging from leading to average classmates. These students should be encouraged and their urge to learn robotics boosted in different activities [1].Field of teaching and learning robotics is very wide and several surveys have been carried out [2],[3],and its design technology is constantly evolving, and new research is being conducted regularly by different scholars.

We highly suggested in order to help solve lack of robotics knowledge among diverse students, teachers should use the following methods and approaches in robot design technology education:

Hands-on projects [4] as the major method and best approach to equip non robotic major students with robotics knowledge, interdisciplinary integration [5], student centered learning, collaborative learning and creation of small groups or clubs for robotics learning[6] and finally expounding on real world application of the robotics field.

In this research, we delved into different resources, and reviewed several curriculum and journals [7] in order to get understanding of the teaching methods that have been used before. It is also important to note that all learners of different majors are supposed to be introduced to basics of robotics before any further steps[8] , several effective teaching methods and approaches hands-on and project based [9],[10] can be employed.

In recent years, different teachers have been using ineffective methods of teaching robotics. They have involved purely theoretical lessons, too much focus on programming, a disconnection from real-world applications, and a lack of practical training. These methods limited students' comprehension and engagement in robotics. Students found it challenging to fully understand the principles without the opportunity to apply them practically. Overlooking the broader aspects of robotics beyond coding restricted their overall grasp of the discipline. A shortfall in hands-on experience also stunted the development of their skills.

2. Hands-on Project Driven Teaching Approach

A hands-on project approach in robotics education offers several benefits. It allows students to actively engage in the design, construction, and programming of robots, promoting practical application of knowledge. This approach fosters problem-solving skills, critical thinking, and creativity. We decided to use hands on project approach to give the best solution robotics education. It also enhances collaboration, communication, and teamwork as students work together to overcome challenges. The hands-on nature of the projects provides a tangible and interactive learning experience, making the concepts more memorable and applicable in real-world contexts.

As to students, project based learning (PBL) is a powerful technique that can be utilized in methods of para-didactic approaches. This method combines the elements of extended real-problem solving with the tools of practical knowledge, skills and imagination. Thus the students make their education meaningful to real life. PBL is the way that engages students to be an active party making them the designer and executor of their project. They just try to figure out topics, do the research, make decisions and present their findings which actually stimulate them and explain they are the owners for learning. PBL may involve group work, both with colleagues and as a team to set plans, design, implement, and create project. This ideal helps students learn about teamwork, communication, and interpersonal skills while working with their classmates, sharing ideas, and presenting their work to peers and key stakeholders. At same time, PBL provides the students with the chance to grapple with problems they encounter, as well as apply theoretical knowledge and practical skills in actual contexts. It also improves applicability, discipline, and the degree of learning effectiveness. The additional benefit of this method is that the understanding of real-life problems is deepened.

The arrangement of the hands-on project driven method is indicated in Fig.1. It is observed that at first learners from different majors are motivated to learn robotics. The teacher gives basics by simplifying the difficult concepts. Team work and problem solving activities leads to practices, designing and building projects. After the learners finish tasks, assessment is carried out, presentation and when all is accomplished learners celebrate their results.

In teaching practices, several examples of successful hands-on projects in robot design technology education have been applied. These projects have been implemented in various educational settings and have proven effective in engaging students and promoting learning

outcomes. Below are some examples:

➢ Robotic arm manipulator assembling: Students manufacturing and assembling robotic arm with multiple functions that can be used for picking up objects, or stacking blocks.

➢ Robot soccer competition program: Students create soccer playing robots and battle it out in a robot soccer competition. This project includes the design and programming for robots that are sensitive to the ball, able to move across the field, and can strive to succeed in scoring a goal.

➢ Varied projects in actually building machines as interaction teaching: Such initiatives can be adjusted or extended if needed according to the students' abilities and instructional goals.

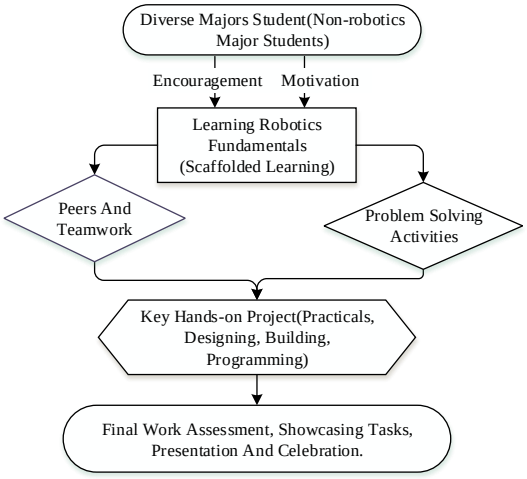

Figure 1: Teaching arrangement of hands-on project driven method

3. Strategies for Implementing Approach in Classroom

3.1. Outlining All Key Objectives

As a teacher you need to clearly define the learning objectives for the hands-on project. What specific knowledge, skills, and competencies do you want students to acquire through the project? It is necessary to align the project goals with the overall curriculum and ensure they are measurable and attainable. The teacher determines the scope and complexity of the hands-on project based on the students' level of expertise and the available resources. Considering the time-frame, available materials, and equipment needed for the project. It is required to break down the project into manageable tasks or stages to guide students through the process. As a teacher it is important to highlight the methods for implementing effective teaching methods to the learners in this learning as far as hands on project approach is concerned.

For hands on project approach to work efficiently the following methods are considered keenly.

➢ Scaffolded Learning. The teacher may split up the project, complex concepts and skills into smaller, manageable parts. In our findings, incorporating hands-on projects into the curriculum requires aligning project goals with overall learning and teaching objectives. The best way to approach this is to be as specific as possible, full of real-world applicability, and to plot out a course that will provide students with the right balance of expertise and resources. Additionally, there is a need to address how much time will be required, which materials will be needed and which tools will be needed for the project. This will make the project much easier and also motivate the students. As a teacher, you would not only employ these methods, but also teach the students how to follow instructions, and will also demonstrate important things for them. We try to create an environment that supports student’s efforts. Then they can practice, explore and truly understand through practical experience. Eventually, by involving in the process, the students get a good grasp

of the subject matter and therefore, come up with valuable conclusions.

➢ Practical applications. We came to know that applying practical implementations of these field is of key importance. Through the linking of the learning to the learners with personal interests and career aspirations, the teacher can make the learners see the potential of robotics beyond mere entertainment entering the picture of fully complicated robotics in different fields. The project-based learning is another element that we have utilized. It makes the robot-building experience more practical and fun by allowing students to solve existing problems or simulate real-world scenarios, which is definitely not a boring experience as they can relate their practice to real life.

➢ Collaborative Learning. Introducing teamwork among non-robotics major students is one of the key shift that we consider essential. The goal of this will be achieved as the teacher arranges for the students to form a group where they are required to cooperate, share ideas and to work together so that they can capitalize on their individual strengths. This way of thinking inspires communications, critical analysis and problem-solving skills. At the same time, this is the place where students share their points of view, routines and experiences. For building a framework of equitability and accountability, the roles and responsibilities have been assigned to each member of the group. This will further create a group atmosphere, and ensure everybody's satisfaction in the end.

Educators can therefore create an inclusive and engaging learning environment for non-robotics major students, enabling them to develop essential skills and knowledge in robot design technology.

3.2. Interdisciplinary Approaches

Interdisciplinary at the crossroads of different knowledge and methods, which, in fact, stimulate innovation, constructive thoughts, and practical problem-solving. Here are a few examples of interdisciplinary approaches in robot design technology education. Incorporation of the interplay between the Science, Technology, Engineering, Art, and Mathematics (STEAM) fields is an essential factor that ensures a student addresses a creative activity at the largest possible extent when designing a could robot. Through introducing art components into the curriculum, the students have a better chance of understanding the correlation between robotics and societal issues.

The blend of computer science and engineering instills in students the conceptual bases for making robots designs. Students will fund computer languages, algorithms, and various data structures to control and work with the robots. On the other hand, they absorb knowledge by using skills such as circuit design, electronics and sensor integration to construct or maintain the robotic system. Integrating entrepreneurship and business concepts in robot design technology courses provides learners with the necessary entrepreneurial skills and capacity that will enable them to excel in business. The students are taught to conduct market analysis, develop a product, devise intellectual property, and find a business model pertinent to robotics.

There are also both benefits and challenges of interdisciplinary approach. By integrating different subject areas, students can explore the technical, artistic, ethical, and business aspects of robotics, developing a well-rounded skill set. Interdisciplinary approaches foster creative problem-solving skills. By combining knowledge and methodologies from various disciplines, students are encouraged to think outside the box and approach challenges from different angles. It thus can foster innovation and the design of solutions to problematic components.

3.3. Student Centered Learning Section

Student-centered learning actively involves students in the learning process, making it more engaging and motivating. Students take ownership of their learning, which can lead to increased interest, enthusiasm, and intrinsic motivation. Student-centered approaches promote active learning,

where students participate, collaborate, and construct their own knowledge. This active engagement enhances understanding, retention, and the ability to apply knowledge in real-world contexts. Student-centered learning recognizes and accommodates the diverse learning needs, interests, and abilities of students. It allows for personalized instruction, differentiated tasks, and various pathways to reach learning goals, fostering a supportive learning environment for all students.

The student focused pedagogy relies on mastery of higher level thinking abilities, by which means the students learn to think critically, solve problems, make decisions, etc. Learners are prompted to take apart, examine, and use knowledge in authentic and complex situations that are relevant to the practical life which aids them in the real-life challenges.

Promote presenting-sharing, engaging in debates, solving problems-based tasks that are interactive and need student involvement as well. We also encourage posing open-ended questions that involve critical thinking and personal opinions that share students' ideas and opinions. It becomes possible for them to arouse their interest in studying by investigating ideas, identifying subjects, and linking theory and practice. Let the students to be in a group or work as a team where they have to share responsibility and the work to be done that should also involve solving of problems collectively. In the way of this, the education system can be designed to involve all students in discussions, exercises, and teamwork activities. Thus, the students are able to develop the specific skills which are needed for good communication and teamwork. Technological equipment like video simulations, e-learning apps and online platforms should be incorporated to provide more tactile and active learning experience to students. This makes them wonder and therefore develop critical thinking and influential task participation.

3.4. Real World Application of Hands-on Projects

Likewise, robotics design technology cannot only be taught to students but also be related to everyday examples. One of the most interesting parts of the robot design technology education is its real application. After all, it being more about the actual function of developing and manufacturing robots than speculative ideas. It gets you out of theory purify domain by providing the students with real-life scenario, which is practicality the same way that in every day. By students taking part in finding solutions, thinking through issues critically, and working in teams to design robots that are targeted real problems to be solved or met in the society. Education is not only about learning theoretical concepts in class, but it also ensures the application of practical knowledge at various levels.

Collaborative learning is an instructional method focused on joint work of students in groups or teams for the purpose of the overall learning goal. Group work stimulates interaction, communication and teamwork that, in turn, facilitates students to express their own views, participate in solving problems together, and get inspired by others. The assessment strategies in robot design technology education are to evaluate student competence in terms of knowledge, skills and abilities in relation to fields in robotics and robotics design technology. In addition to the regular assessment e.g. tests and quizzes, alternate assessments such as more authentic methods could be used. These components might be project (hands-on) evaluations like students construct, test, and display their robotic products, which is more useful. Also, the pupils will have an opportunity to apply and show what they have learned directly.

4. Conclusions

Working on robot design educational sector that is supportive to the non-robot majors is an invaluable tool that can be taken advantage of and can build a formidable skill set. This feature totals up the disciplinary, problem-solving, and cognitive skills which are enhanced as students

view how to acclimatize to the technology-infected world. And with an opportunity to build and present their own work, these students receive a hands-on experience of the field, robotics new capabilities, and how it is applied in other areas. As a result, their learning process is improved with significant insights into article, and their work prospects post higher education. While significant progress has been made in understanding teaching methods for non-robotics major students in robot design technology education, there are still several areas that warrant further research and investigation. Firstly, there is a greater need for interested scholars and researchers to explore the integration of emerging technologies, such as virtual reality, augmented reality, or robotics simulations, in hands-on projects and teaching methods for robot design technology education. Another second important area is to investigate the impact of these technologies on student engagement, learning outcomes, and the development of practical skills.

In summary for future research in the field of robot design technology education for non-robotics major students can explore several aspects, it would be useful to investigate the impact of different teaching methods and instructional approaches on the learning outcomes of non-robotics major students. This can include comparative studies on the effectiveness of scaffolded learning, project-based learning, and collaborative learning in enhancing understanding, engagement, and skill development. Moreover, research can delve into the design of curriculum and learning materials that are accessible and engaging for non-robotics major students, taking into account their diverse backgrounds and interests.

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