World Academy of Science, Engineering and Technology
International Journal of Educational and Pedagogical Sciences
Vol:17, No:08, 2023

Framework Proposal on How to Use Game-Based Learning, Collaboration and Design Challenges to Teach Mechatronics

Authors : Michael Wendland

Abstract : This paper presents a framework to teach a methodical design approach by the help of using a mixture of game-based learning, design challenges and competitions as forms of direct assessment. In today's world, developing products is more complex than ever. Conflicting goals of product cost and quality with limited time as well as post-pandemic part shortages increase the difficulty. Common design approaches for mechatronic products mitigate some of these effects by helping the users with their methodical framework. Due to the inherent complexity of these products, the number of involved resources and the comprehensive design processes, students very rarely have enough time or motivation to experience a complete approach in one semester course. But, for students to be successful in the industrial world, it is crucial to know these methodical frameworks and to gain first-hand experience. Therefore, it is necessary to teach these design approaches in a real-world setting and keep the motivation high as well as learning to manage upcoming problems. This is achieved by using a game-based approach and a set of design challenges that are given to the students. In order to mimic industrial collaboration, they work in teams of up to six participants and are given the main development target to design a remote-controlled robot that can manipulate a specified object. By setting this clear goal without a given solution path, a constricted time-frame and limited maximal cost, the students are subjected to similar boundary conditions as in the real world. They must follow the methodical approach steps by specifying requirements, conceptualizing their ideas, drafting, designing, manufacturing and building a prototype using rapid prototyping. At the end of the course, the prototypes will be entered into a contest against the other teams. The complete design process is accompanied by theoretical input via lectures which is immediately transferred by the students to their own design problem in practical sessions. To increase motivation in these sessions, a playful learning approach has been chosen, i.e. designing the first concepts is supported by using lego construction kits. After each challenge, mandatory online quizzes help to deepen the acquired knowledge of the students and badges are awarded to those who complete a quiz, resulting in higher motivation and a level-up on a fictional leaderboard. The final contest is held in presence and involves all teams with their functional prototypes that now need to contest against each other. Prices for the best mechanical design, the most innovative approach and for the winner of the robotic contest are awarded. Each robot design gets evaluated with regards to the specified requirements and partial grades are derived from the results. This paper concludes with a critical review of the proposed framework, the game-based approach for the designed prototypes, the reality of the boundary conditions, the problems that occurred during the design and manufacturing process, the experiences and feedback of the students and the effectiveness of their collaboration as well as a discussion of the potential transfer to other educational areas.

Keywords : design challenges, game-based learning, playful learning, methodical framework, mechatronics, student assessment, constructive alignment
Conference Title : ICICE 2023 : International Conference on Innovative and Creative Education
Conference Location : New York, United States
Conference Dates : August 10-11, 2023