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Engineering Design of a Chemical Launcher: An Interdisciplinary Design Activity

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Abstract : Academic performance, in the form of scoring high grades in enrolled subjects, is not the only significant trait in achieving success. Engineering graduates with experience in working on hands-on projects in a team setting are highly sought after in industry upon graduation. Such projects are typically real world problems that require the integration and application of knowledge and skills from several disciplines. In a traditional university setting, subjects are taught in a silo manner with no cross participation from other departments or disciplines. This may lead to knowledge compartmentalization and students are unable to understand and connect the relevance and applicability of the subject. University instructors thus see this integration across disciplines as a challenging task as they aim to better prepare students in understanding and solving problems for work or future studies. To improve students' academic performance and to cultivate various skills such as critical thinking, there has been a gradual uptake in the use of an active learning approach in introductory science and engineering courses, where lecturing is traditionally the main mode of instruction. This study aims to discuss the implementation and experience of a hands-on, interdisciplinary project that involves all the four core subjects taught during the term at the Singapore University of Technology Design (SUTD). At SUTD, an interdisciplinary design activity, named 2D, is integrated into the curriculum to help students reinforce the concepts learnt. A student enrolled in SUTD experiences his or her first 2D in Term 1. This activity. which spans over one week in Week 10 of Term 1, highlights the application of chemistry, physics, mathematics, humanities, arts and social sciences (HASS) in designing an engineering product solution. The activity theme for Term 1 2D revolved around "work and play". Students, in teams of 4 or 5, used a scaled-down model of a chemical launcher to launch a projectile across the room. It involved the use of a small chemical combustion reaction between ethanol (a highly volatile fuel) and oxygen. This reaction generated a sudden and large increase in gas pressure built up in a closed chamber, resulting in rapid gas expansion and ejection of the projectile out of the launcher. Students discussed and explored the meaning of play in their lives in HASS class while the engineering aspects of a combustion system to launch an object using underlying principles of energy conversion and projectile motion were revisited during the chemistry and physics classes, respectively. Numerical solutions on the distance travelled by the projectile launched by the chemical launcher, taking into account drag forces, was developed during the mathematics classes. At the end of the activity, students developed skills in report writing, data collection and analysis. Specific to this 2D activity, students gained an understanding and appreciation on the application and interdisciplinary nature of science, engineering and HASS. More importantly, students were exposed to design and problem solving, where human interaction and discussion are important yet challenging in a team setting.

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