Interdisciplinary experience with Tangram: improving the engagement of STEM students

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Abstract. Student engagement is essential in any learning process, but specially in Science, Technology, Engineering and Mathematics (STEM) education. An interdisciplinary activity has been developed to increase engagement by means of creativity and an active learning strategy. Small teams of students have to create Tangram figures to be used as pendants, and afterwards, they have to calculate and validate the position of the mass centre of one of them. Student learning was assessed, and we have observed better results than in traditional teaching. Moreover, we have detected more interest of the students, because they work with figures created by themselves.

1 Introduction

The lack of student engagement in introductory STEM courses is an important obstacle to purchase academic achievement [1]. Then, the question is, how can we enhance the student engagement? Different strategies have been developed to improve the engagement of the students [2, 3]. Current evidence shows that active learning strategies increase the engagement of students in the learning process [4]. Moreover, the motivation of students increases in activities in which creative thinking and aesthetic aspects, usually related to Arts, are involved [5]. Combination of Art skills and STEM is frequently called STEAM.

This document presents a complementary activity to traditional teaching, designed to enhance student interest in STEM. The principal aim of the experience is to improve the engagement of the students in the development of skills related to mass centre calculation. This calculation integrates in the same activity knowledge of different STEM disciplines: Physics, Mathematics, Informatics and CAD Drawing. The activity has been designed to be interdisciplinary and cooperative in nature, to help conceptual knowledge development. As a first step of the activity, we have included a divergence/convergence phase of creativity to improve engagement.

2 Methodology

This interdisciplinary experience has been performed with students of Industrial Design and Product Development Engineering degree of Mondragon Unibertsitatea (MU). They have been grouped in teams of 3-4 students. Each student team has a tutor to help in the cooperative development of the experience, and one expert for each technical discipline.

Tangram is an old and simple Chinese puzzle game, which has seven flat pieces, called tans [6]. In order to obtain more complex figures, we have provided two other circular pieces (see Fig. 1). The aim of the game is to create figures with given silhouettes. We have proposed students to create four complex figures to be used as pendants. In those pendants, they have to use at least one of the two circular tans and some pieces of the normal Tangram puzzle. We want the students to develop their creativity; therefore, the originality of the figures will increase the score obtained by each student team. For example, symmetric figures have a low score. Once they have created the four figures, they have to choose one of them, and they have to explain the selection.

In the second phase of the activity, student teams have to calculate the mass centre of the designed figure integrating skills of different disciplines: Physics, Mathematics, Informatics and CAD Drawing.
In the last phase of the activity, students have to check the theoretical results with an experimental validation (see Fig. 1). They construct a foam-core-board version of the selected figure, and they measure the position of mass centre in that figure. Finally, each team has to write a document (maximum 10 pages) to describe all the work, compare the results, and explain and justify the differences between them. Experts evaluate the technical information of this document, and each tutor assesses the cooperative work of the team. This interdisciplinary experience finishes with a feedback meeting with each student team.

3 Conclusion

The creative phase of the experience helps to motivate students to really engage with the activity. We have observed better student attitudes during this team-based experience. Moreover, students develop a creative and critical thinking skill, individual responsibility and enhance their calculation, drawing and writing capacities. This activity increases the cohesive understanding of the different strategies to calculate the mass centre, improving the conceptual knowledge of students.

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References