Addressing the interdependence attributes of undergraduate students through problem–based project

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ABSTRACT – One of the important attributes in developing human capital at the university level is interdependence. In this attribute, students are trained to solve high-level problems which consist of several components or sub-problems. In order to achieve this attribute, a problem-based project tailored to enhance the attribute is planned. In this paper, teams of five members for third-year students of Mechanical Engineering undergraduate course at Universiti Teknikal Malaysia Melaka are given a problem-based project for their Mechanical Design subject. The project is started with requirements to produce a product for a specific application. The product consists of several mechanical components which have to be considered. Starting from sketch design, design selection, calculation and analysis, design optimization, and finally product presentation, the students are required to produce a comprehensive report for the product. At the end of the semester, this report which additionally consists of the contribution of each member is evaluated for their subject grade. Since the project is directly mapped to the interdependence attribute, the final mark of the project is reflected the students' achievement on the related attribute.

1. INTRODUCTION

The interdependence attribute can be defined as two or more people or things depending on each other. For example, the human interdependence between teachers and students, human to thing interdependence between students and computers, and things interdependence shaft and bearings.

Previous researchers have demonstrated the positive attributes in students with positive relationships with teachers [1, 2]. Even though the attributes are commons, the human interdependence attribute is proven to be significant for learning and teaching activities. A method called heutagogical learning was introduced by Stoszkowski and McCarthy [3]. This self-determined learning method where a student-centered instructional strategy, emphasized in the development of autonomy, capacity, and capability of the student. It successfully shows the students' perceptions of the required attributes. Statistically, different attributes for students have been successfully evaluated using machine learning [4] and data mining techniques [5]. Huge data with a lot of samples were analyzed using these techniques. ElAtia et. al [6] and Petrusch & Vaccaro [7] stated that the students' attributes can be assessed and valued including the main attribute which is interdependence. Another application where the human interdependence attribute comes beneficial is in a nursing program. The students' attributes for the ideal nurse are important in providing better services to the patients [8]. Often, higher learning institutes improvise and implement certain attributes for their students such as tolerances [9], leaderships [10], and critical thinking [11]. Furthermore, special attributes become an advantage in increasing their earnings [12]. The interdepended attribute can be also experienced through music education [3] depending on the classrooms' conditions [14] and intercultural collaborative learning [15]. However, students might pretend to enjoy the class group activities when they realize the interdependence attribute is being assessed by the teacher [16]. Nevertheless, the interdependence attribute in social skills including sociocognitive, motivation, and achievement may have a longitudinal effect on the social psychology of the students [17]. For engineering students, most of the approaches performed by instructors are by motivating [18], observing [19], and exploring [20] the behaviors of the students through interdependence tasks. The tasks are usually incorporated with risks and uncertainties.

This paper focuses on the interdependence among things and problems. The students are required to design a product that consists of several interdependent components. Without one component, the product will fail, and overdesign of a certain component will overshadow the others and still, the product will not function as planned.

2. METHODOLOGY

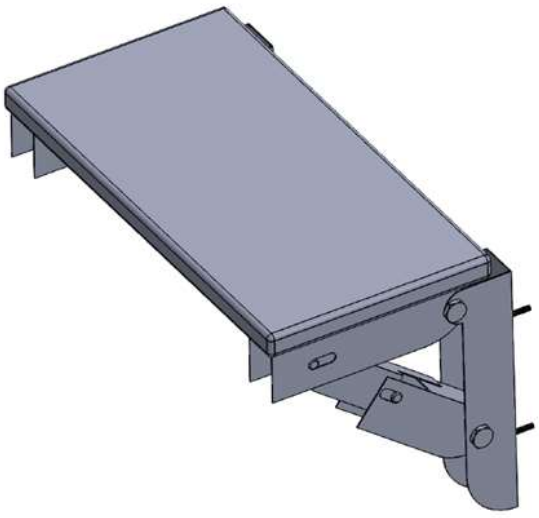
The interdependence attribute of the students is measured by the team project and report. The students are divided into a few teams with 5 members. Each team is given the same theme of product for a certain application. The final marks of the reports represent the score of the attribute of the students. Since the marks are for a team, each member of the team scores the same attribute mark. The interdependence attribute is compared among 3 batches of students with more than 200 students per batch. Batch A is the students of Semester 1, 2018-2019, Batch B is the students of Semester 1, 2019-2020, and Batch C is the students of Semester 2, 2020-2021.

The score of interdependence is divided into three categories, Low for marks less than 50%, Mid for marks between 50% to 80%, and High for marks above 80%. Furthermore, the average score, standard deviation, and variance are analyzed and compared among batches.

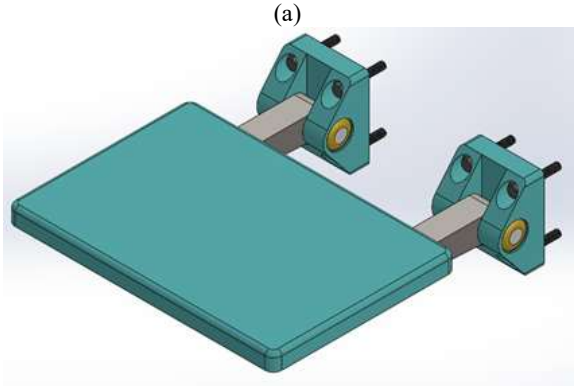
1) Project 1: Foldable furniture
   Interdependence attributes – stress analysis, safety, bolt dimensions, number of bolts, folded envelope size, materials
2) Project 2: Hand tools' hack
   Interdependence attributes – stress analysis, safety, cutting tools, complexity, materials
3) Table and chair combo
   Interdependence attributes – stress analysis, safety, ergonomic, materials

3. RESULTS AND DISCUSSION

Figure 1 shows examples of Project 1 products which are the foldable table and chair for wall mounting produced by Batch A students. In this project, the important characteristic is the ability of the furniture to be folded. Interdependence attributes in this project are the safety factor analysis, bolt selection, and envelope size. Figure 2 shows examples of Project 2 products which are the angle grinder shredder and hand drill tiller produced by Batch B students. Interdependence attributes include the mounting design of the hand tool, the cutting tool selection, and the rotating mechanism. Figure 3 shows the examples of Project 3 products which are the advanced and simple table and chair combo produced by Batch C students. The interdependence attributes consist of ergonomic and safety analysis.

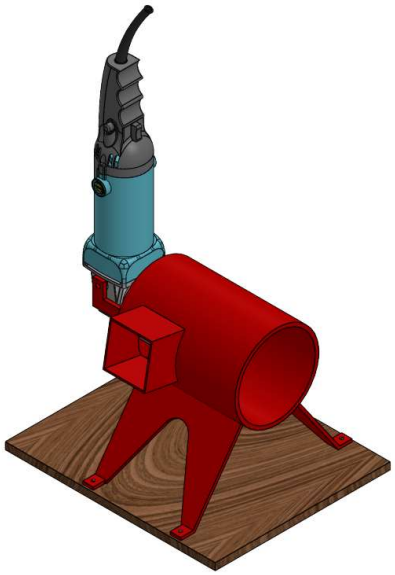


(a)

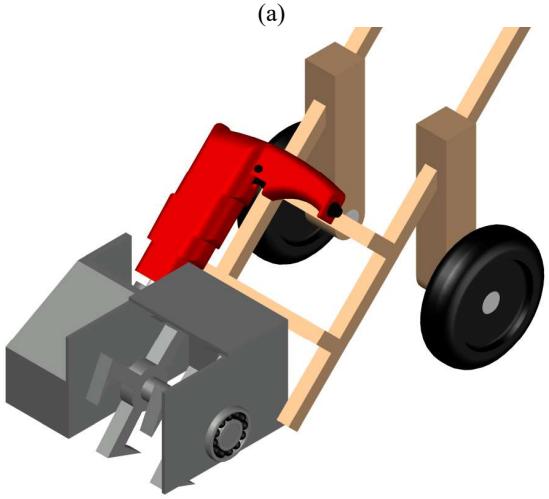


(b)

Figure 1 Foldable (a) table, (b) chair



(a)

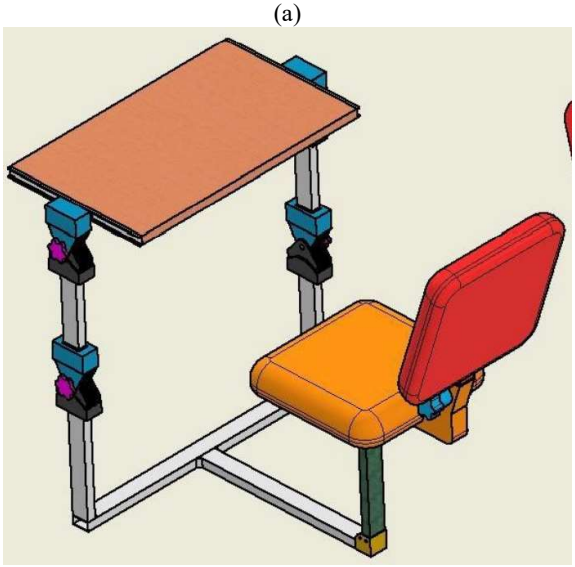


(b)

Figure 2 (a) Angle grinder shredder, (b) hand drill tiller

Table 1 summarizes the interdependence scores by each batch of students. The majority of the students for all batches score between 50 % to 80 % marks which are the mid-value of the interdependence score. Comparing all batches, the top scorers are batch B with 105 students scoring high interdependence attributes. The highest average score was Batch A with 7.82 or 78.2 % interdependence attributes.

(a)



(b)

Figure 3 (a) Advanced and (b) simple table and chair combos

Table 1 Interdependence marks and score

Batch	Number of students	Project	Interdependence Score			Average	Standard Deviation	Variance
			Low	Mid	High			
A	230	1	11	117	102	7.82	1.42	2.02
B	233	2	3	125	105	7.75	1.51	2.28
C	292	3	52	198	42	6.60	1.46	2.14

4. CONCLUSION

On average, all batches score roughly about the same value for the interdependence attributes. With low standard deviations and variances, the scores are considered acceptable. The scores also prove that majority of the students are in the mid-range in reflecting the interdependence attributes. Nevertheless, if the year of the batch is considered, perhaps, the course performed by the online method scores fewer interdependence attributes compared to face-to-face teaching and learning.

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