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SUCCESS FRAMEWORK FOR TEACHING ERGONOMICS TO ENGINEERING STUDENTS

MUSHTAK AL-ATABI, SATESH NAMASIVAYAM*

School of Engineering, Taylor's University, No. 1 Jalan Taylor's
47500 Subang Jaya, Selangor DE, Malaysia
*Corresponding Author: satesh.namasivayam@taylors.edu.my

Abstract

Taylor's University School of Engineering (Malaysia) is a project-based-learning school that puts a conscious effort to educate engineers on the importance of applying ergonomic principles at the conceiving and designing stages of a product life cycle. This paper reports on an innovative approach to teaching ergonomics using the SUCCESS framework (Simple, Unexpected, Credible, Concrete, Emotions, Story, and Simulation). This teaching technique was adopted to engage the hearts and minds of the students and get them to embrace ergonomics as an important skill for engineers. Comparing students' module evaluation and feedback, both before and after the adoption of the SUCCESS framework showed that students enjoyed the new approach of teaching and found it more fulfilling.

Keywords: SUCCESS, Ergonomics, CDIO, Pedagogy, Innovation.

1. Introduction

Taylor's School of Engineering uses project based learning to train engineers who are ready for employment and beyond [1]. It adopts the CDIO (Conceive, Design, Implement, Operate) framework [2] and students enrol for a project-based module for every semester of their studies. The School offers three Bachelor Degree Programmes, namely, Chemical Engineering, Electrical and Electronic Engineering and Mechanical Engineering, and the project-based modules are offered collectively to the students from the three-degree programmes. The first Programme Outcome of these programmes reads, "Apply the knowledge of mathematics, science, engineering practices, innovation techniques, entrepreneurship and ergonomics to provide value-adding solutions to complex engineering challenges." Clearly, knowledge of ergonomics and its applications is

an important part of the engineering programmes at Taylor's and a graduate needs to exhibit proficiency in applying ergonomics principles.

Despite the importance of studying ergonomics for engineering students, Woodcock and Galer Flyte [3] indicated that ergonomics is still not fully integrated into product design and engineering environments and they identified four broad reasons for this as follows:

- A design process that does not incorporate the ergonomics information.
- Education curriculum that focuses on the development of hardware rather than the user.
- The contradiction that may occur between ergonomics and other product development criteria.
- Scarcity of information about ergonomics in a manner accessible to designers.

To address the first and second points above, all engineering students at Taylor's University are required to take a three-credit-hour module entitled "Engineering Design and Ergonomics" in their second year. This project-based module is aimed at equipping the students with the necessary ergonomic and human factor engineering knowledge and skills to enable them to design easy to use safe products and systems. However, it was noticed that students are unable to appreciate the relevance of this module to their overall engineering career. This is especially true for chemical engineering students. These disappointing finding can be attributed, at least in part, to the third and fourth points outlined above.

This paper reports on the use of the SUCCESS framework described by Heath and Heath [4] to deliver key parts of the ergonomic module to engage the students and establish the ergonomics module. The SUCCESS framework and how it is implemented in the module is outlined and the benefits achieved are summarised.

2. Engineering Design and Ergonomics

Engineering Design and Ergonomics is a three-credit-hour module offered to all engineering students in their second semester of year 1. The learning outcomes of this module are

1. Explain the social and ethical issues related to engineering practice.
2. Explain the essential working elements of project management.
3. Assess risk, health & safety, and environmental issues related to a design or manufacturing project.
4. Design a simple consumer product to suit a specified human user (or a simple manufacturing process to suit specified human operators).
5. Compile and appraise information and research findings.
6. Produce written reports.

In this module, students are required to work in multidisciplinary teams to conceive, design, implement and operate a simple consumer product (or manufacturing process) keeping in mind the user and/or operator requirements. The module also involves the delivery of a number of related lectures including health and safety, human factor engineering as well as anthropometry.

Despite the importance of this module, some students were unable to appreciate its importance. In the April 2012 semester, 91% of students provided negative feedback when they were asked about how they perceived this module. This was particularly true for chemical engineering students. From the comments provided by students, their ability to realise the relevance of this module and how it is necessary for their future professional development was a challenge. As engineering students, they see ergonomics to be in the realm of the designers rather than theirs.

3. SUCCESS Framework

For the purposes of prediction and analysis of aerodynamic characteristics, a computer programme is developed. The restrictions, capabilities, and the flow charts of the programme are given in *Appendix B*.

Malcolm Gladwell in his book "Tipping Point" [5] studied the mechanisms in which certain ideas "tip" into becoming widespread trends. These mechanisms, according to Gladwell, are the Law of the Few, the Stickiness Factor, and the Power of Context. The Law of the Few refers to the key influential individuals who need to champion the idea, while the Stickiness Factor is related to how memorable and impactful a message or idea is for it to "tip". The power of context refers to a broad timing and environmental factors that set the right background for an idea.

Inspired by the "Stickiness Factor" described by Gladwell [5], Chip and Dan Heath in their book "Made to Stick," [4] identified six attributes of effectively designed messages that enable them to "stick". These attributes are for the message to be Simple, Unexpected, Credible, Concrete, Emotional, and told using a Story, hence the acronym SUCCES. The authors of this paper propose a seventh attribute, Simulation to complete the framework into SUCCESS.

In order to get the students appreciate the ergonomics module, the authors used the SUCCESS framework to engage the hearts and minds of students. This was done by redesigning key lectures to include the SUCCESS attributes. This paper describes how this was done to the Anthropometry lecture.

3.1. Anthropometry lecture redesign

Anthropometry is an important part of the study of ergonomics as it deals with statistical data about the human body measurements, which can help design comfortable and optimised products and processes. To deliver the lecture using the SUCCESS framework, the authors used condoms and penal size as the centrepiece of the lesson. To provide a proper context, the authors developed a case study that is based on the widely reported news that the standard condom size is too large for Indian males [6] resulting in wide avoidance of the use of condom which can contribute to unwanted pregnancy and the spread of sexually transmitted diseases.

For maximum impact, students are told the story of "Anna" who is a 5-year Indian child that is HIV positive because her parents opted to have unprotected sex although the father knew that he was HIV positive. This is followed by distributing a case study that reports on World Health Organisation (WHO) data on the failure to encourage Indian males to even use free condom, simply because it is of the

wrong size. After discussing the case study and establishing the role of ergonomics and engineering in the design and manufacturing of condoms, different techniques of establishing the penal size for a certain population are explored. The lecture ends with examination of condoms made by different leading manufacturers and the students get to inflate real condoms. The approach makes sure that all the SUCCESS attributes are properly addressed as shown in Table 1.

Table 1. SUCCESS Framework Applied to Anthropometry.

Attribute	How it was addressed
Simple	The case study is simple and easily comprehensible.
Unexpected	The condom is the last thing the students expect to be related to ergonomics.
Credible	The case study is based on real data from WHO and other credible sources.
Concrete	The case study and the condom are concrete and tangible.
Emotions	Anna's story is very personal and emotional.
Story	Anna's story as well as the story of the males refusing the use of condoms.
Simulation	Inflating the condom at the end of the lecture is as close to simulation as it can get.

3.2. Students' feedback

In order to assess the satisfaction of the students after the implementation of the SUCCESS revamped lecture, students were asked to give feedback in two forms as follows:

a) Immediate feedback: the authors sought written feedback from the students immediately after the end of the SUCCESS lecture. 93% of the students provided positive written feedback. Their comments included "interesting topic, fun learning, lively and good teacher".

b) End of Semester feedback: all modules offered by Taylor's School of Engineering in all three programmes seek formal feedback from the students in the form of a module evaluation survey. The following questions are posed to the students to answer and provide feedback.

1. The outline and expectations for this module as supplied by the lecturer were clear.
2. The lessons were well organised and prepared.
3. The lecturer was knowledgeable about the module content.
4. The module content was effectively presented.
5. Opportunities were provided for student participation.
6. The homework and classroom assignments were helpful.
7. The textbooks and/or recommended materials were useful.
8. The lecturer was available for consultation and was helpful.
9. The assessment was fair.
10. This module met my needs and goals for future study and/or employment.

Figure 1 illustrates and compares the survey results obtained for the ergonomics module in April 2012 (the semester where SUCCESS was not used) and September 2012 (the semester where SUCCESS was used).

It can be seen from Fig. 1 that a marked increase in the median score of all survey questions were observed. In addition to this, the number of positive comments observed in the September 2012 semester increased by 57.7% (compared to the number of positive comments observed in April 2012), resulting in 66.7% of students providing positive feedback about the module and its lecturer.

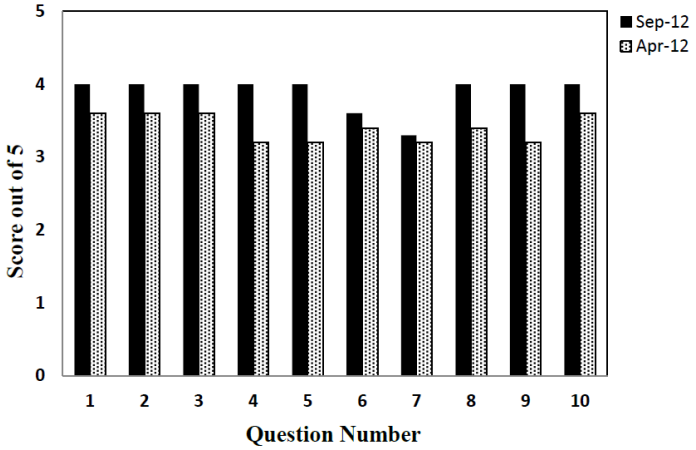

Fig. 1. Students Assessment of the Ergonomics Module – Comparison of April 2012 and September 2012 Semesters Course Evaluation Survey Results.

4. Conclusions

SUCCESS framework was used to revamp a Design and Ergonomics module offered at Taylor's University School of Engineering. The students responded well to the change and this is expected to have an overall positive impact on how they perceive ergonomics and how they apply it as they conceive and design products and processes.

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