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Effectiveness of Sustainability in Engineering Education: Research Methods

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The motivation of this research is to comprehend the changes in transforming engineering education, in particular to provide the next generation of engineers with sustainability attributes and competencies. The change includes integrating education about sustainability into existing engineering education, introducing a field of disciplines that specializes in sustainability and establishing engineering research on sustainability [1].

At the early phase of this research, the stand-alone and the integrated models were presented as strategies in introducing of sustainability courses in engineering education. Later, the models were further developed conceptually in three dimensions which include approaches and orientations [2]. This concept of characterizing courses confirmed the existence of other kind of courses which were poorly structured and less effective. The existence of these courses motivated this researcher to study the effectiveness of courses for sustainability in engineering education.

The main expected outcome of the research is to design a framework that will integrate sustainability in engineering curricula. Subsequently, the framework will provides course developers with important elements to integrate sustainability in designing a course. Furthermore, the framework also will offers course developers structured design procedures and inspires developers with the positive effects of the teaching methods. To achieve the research outcomes, several real experiences and effective courses will be evaluated and analyzed, and the results then will be presented as the design procedures and exemplary teaching methods.

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A mixed methods design was employed to obtain data from a group of course developers, teachers and students. A part of this study, qualitative data are viable in addressing research problems in which interview transcripts and observation reflections can ascertain the process of developing the courses. Document analyses also are very helpful in providing important inputs. In the other part of this study, quantitative data are feasible to address research problems such as to determine the effectiveness of the courses. The combination of qualitative and quantitative data provides a thorough understanding in addressing research problems, in particular to provide complementary qualitative data if quantitative data are inadequate [3].

The research model was developed by adapting the basic cycle of design, investigate-plan-develop-evaluate, and will be used as overall research model. The cycle of the research model consists of four phases which includes qualitative and quantitative research methods. For phase one, the framework for course design was developed by reviewing sustainability courses across continents and collecting real practice feedbacks from experts and practitioners in sustainability. Outcomes from the phase one will serve as a base in developing instruments for the next phase. Two of the phases, phase two and phase three, will be focused on developing the framework for course design. Two case studies will be conducted at the phase two. It is expected that the in-depth case studies research will be able to point out the potential variables used to develop evaluation tools and indicator as well as to redesign the framework.

The phase three is the non-experimental research approaches. At this phase, effectiveness of five selected sustainability courses will be evaluated and indicated. Three types of evaluation tools to evaluate the effectiveness of sustainability courses were identified. The evaluation tools will use numerical values for evaluating the students' learning outcomes in term of knowledge, skills and attitudes. This non-experimental approach intended to evaluate the offered sustainability course without intervention on existing course design. Therefore, the real practices can be justified and be the solutions of the main research question, which is to construct effective frameworks of course design.

The final phase is set in place to conduct validity tests on the proposed frameworks of course design. The proposed frameworks are used to develop an effective sustainability for both types of course structure. Two groups of course designers were assigned for the tests. The outcomes of the tests are feedbacks on the framework design. ■

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