

# An Environmental Learning Support System Incorporating the Life Cycle Concept

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According to Ilgin et al. (2010) and United State Environmental Protection Agency (EPA, 2012), life cycle assessment (LCA, also known as life cycle analysis) is a methodology for assessing environmental impacts associated with all the stages of the life cycle of a commercial product, process or service. For example, in the case of a manufactured product, environmental impacts are assessed from raw material extraction and processing (cradle), through the product's manufacture, distribution and use, to the recycling or final disposal of the materials composing it (grave). Studies on LCA involve a thorough inventory of the energy and materials that are required across the industry value chain of the product, process or service, and calculates the corresponding emissions to the environment. Thus, LCA assesses cumulative potential environmental impacts, and it aims to document and improve the overall environmental profile of the product.

Regarding the environmental education scene, efforts to incorporate the life cycle concept into the learning program have been occasionally seen (Hondo, 2008). The significance of incorporating the life cycle concept in environmental learning is that, first, learners can more easily make specific connections between daily consumer activities and environmental problems, and recognize that their own behavior choices are deeply involved with global environmental problems, by learning about the life cycle concept. Second, learners can quantitatively compare and determine the environmental impact, which tends to be qualitatively assessed, by learning about the direct assessment and analysis method of the environmental impact called the LCA.

Based on the above, the present study aims to develop an e-learning system to support environmental learning based on the life cycle concept. The present study can be summarized in the following 3 points.

- (1) An e-learning system, which is made up of 3 parts including text-based learning materials, quizzes to review the content of the learning materials, and CO<sub>2</sub> emission simulation, was designed and developed with the purpose of supporting environmental learning. Users that were expected to be from a wide range of age groups were recruited, and the system was operated and evaluated.
- (2) The operation period of this system was 1 month. Based on the results of questionnaire survey for users, it was evident that the quiz function and the simulation function of CO<sub>2</sub> emission contributed to the efficiency in environmental learning, and the format of the e-learning system was effective and helpful for environmental learning. Additionally, with the users' awareness related to environmental conservation before and after using the system, significant changes in awareness were seen in areas such as behavioral intention, sense of urgency and sense of connection. On the other hand, there were no major changes in awareness concerning the sense of effectiveness, responsibility and feasibility, and there was also no desirable change for a sense of burden.
- (3) According to the access analysis of the log data during the operation period, it was revealed that 62% of the total access numbers were from mobile devices. Therefore, it was effective to prepare an interface optimized for mobile devices enabling users to use the system from their smartphones and tablet PCs.

**Keywords:** Environmental Learning, Life Cycle Assessment (LCA), Life Cycle Concept, Environmental Education, Sustainable Development Goals (SDGs), E-learning System