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Appraisal of Learning Objectives of a Course in Construction Science

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Abstract

The purpose of the study was to appraise the learning objectives of an Environmental Control Systems course in construction science at an undergraduate level offered in a university in Texas. Both the accrediting bodies and the university make it mandatory to assess courses and programs. The instructors of record are expected to measure student learning as per the objectives stipulated in the syllabus. The study was conducted in Spring 2012. The perceptual importance of the learning objectives of the course was measured both before and after the course was taken by the students. An instrument was developed for the purpose. It was administered once at the beginning of the semester and once at the end of the semester. The total number of students was 54. Only the responses of students who participated in both the surveys were used for analysis. The final sample size was 39. The statistical technique used for data analysis was General Linear Model. The results of the study validate the importance of all learning objectives.

Key words: Assessment, Construction Science, Course Learning Objectives, Environmental Control Systems.

Introduction

Program Quality Assessment

Institutions of higher learning are becoming increasingly involved with the continual improvement of their educational programs. It incorporates planning, assessment, and an implementation/revision cycle. Most of the universities and accrediting bodies require a regular assessment of both program objectives and individual course learning outcomes. The general purpose the assessment of an academic program is to measure its impact on continual learning, growth, and development of the students as they go through the process.

The levels of a program assessment include:

- Assessment of student learning of course content at individual level
- Assessment of the learning outcomes at course level
- Assessment of an entire program at departmental level
- Assessment of campus-wide characteristics and issues at institutional level

The focus this study was to examine the importance of student learning objectives for environmental control systems at a course level.

Course Learning Objectives

Learning objectives illustrate the knowledge, skills, and values that learners should able to demonstrate in terms of knowledge, skills, and values upon completion of a course or a program. The effectiveness of a learning process depends on well-defined learning. For a course, they are clear statements that spell out the intended proficiency or skill that the students should attain on completion of the contents of a course[1]. Absences of learning outcomes may lead to (1) poor understanding and grasp of basic concepts of the course and, consequently, (2) an inability on the part of learners to apply the knowledge to follow-up courses or in real life situations.

Generally speaking, five different types of learning objectives are recognized at higher levels of education[2]:

- Competency: An understanding of information, skills, and approaches needed to perform a specific task effectively and efficiently at a defined level of performance.
- Movement: A documented progress in a skill that can be transferred across disciplines.
- Accomplishment: A body of work that transcends beyond normal requirements and is externally affirmed by experts in the field.
- Experience: An amalgamation of interactions, feelings, accountabilities, and recollections that clarify one's position in relation to the discipline or society, at large.
- Integrated performance: A synthesis and application of prior knowledge skills, processes, and attitudes with new learning.

Each type is suited to specific educational approaches and requires collection of evidence to demonstrate the achievement of the outcome. The learning outcomes related to this study deal with competency.

There are two courses on Environmental Control Systems that are offered at the institution where the author teaches. One of the courses deals with heating, ventilation, and air-conditioning systems for buildings. Students of construction science need to take the course in order to become competent professionals. Contents of the course include:

- Quantification of building heat losses and gains.
- Description of heating-cooling equipment operation.
- Sizing, selection, and detailing of heating-cooling systems in buildings.
- Integration of heating-cooling components with other sub-systems of buildings.
- Evaluation of energy-conserving opportunities and alternatives.

Learning Objectives of Environmental Control Systems

Objective 1

Students will develop an understanding of the relationship between site and comfort conditions in a built environment.

Objective 2

Students will develop an understanding of how to calculate the heat gain and heat loss for buildings and how that information is used in the design and selection of component parts of the heating, ventilation and air conditioning systems.

Objective 3

Students will develop an understanding of how to select the equipment required for HVAC systems.

Objective 4

Students will develop an understanding of sizing ducts and registers in an HVAC system.

Objective 5

Students will develop an understanding of how the component parts of a heating, ventilation and air condition system must fit within a structure.

Student Perception of Learning Objectives

Student performance in a course is traditionally used as a measure of student learning, but it provides only a narrow view of the effectiveness of learning objectives of a course. A complete measure of student learning objectives goes beyond student performance. It should encompass a perception about their interest in the subject, relevance of the course contents with reference to their discipline, intrapersonal objectives, and broad course objectives. We know that what happens in the minds of our students is more important than what the instructor thinks about student learning.

The importance of a course lies in its ability to present information that helps the students perform well both academically and professionally[2]. It should evident to the students from a set of clear learning objectives. Studies indicate that exposure to course materials over a period of time affects students perceptions of importance of the subject areas subsumed by the course[3,4,5].

In their study of a project management course, Case and Tabatabaei[4] report that student perceptions of the importance of the subject matter increased significantly after they completed the course. An evaluation of student perception of a course on agriculture by Duncan et al.[5] shows that a statistically significant change in student perceptions took place toward specific agricultural issues such as biotechnology, environment, and humane treatment of animals.

In this study, it was attempted to validate the learning objectives of a course on Environmental Control Systems by performing a comparative analysis of student perceptions of their importance before and after the course was completed.

Methodology

Study Population

The study population was the body of students who registered for an Environmental Control Systems course at an undergraduate level in a state university for Spring semester in 2012. The total number of students was 54. All the students were either at junior or senior level. They were already exposed to the basic construction science courses.

Two sets of data were collected, one at the beginning of semester and one at the end of the semester. Only the responses from students who participated in both the surveys were used for analysis. The final sample was the sample size was 39. Five of the students were female and 34 were male.

Data Collection

A paper-based survey instrument was used in this study. It was used both at the very beginning and end of the semester. The instrument had two parts.

In the first part, the students were asked to rate the overall importance of the course (termed as OVERALL) with reference to the profession of construction. The rating was on a Leikert-like scale ranging from 1 to 7 (see Table 1).

The second part of the instrument dealt with perceptual importance of the course learning objectives with reference to the course as a whole. This rating was also on a Leikert-like scale ranging from 1 to 7 (see Table 1).

Table 1. Perceptual importance scale for the course and learning objectives

Perception	Score
Extremely unimportant	1
Unimportant	2
Somewhat unimportant	3
Neutral	4
Somewhat important	5
Important	6
Extremely unimportant	7

The instrument was administered twice, once at the beginning of the semester (before the students were exposed to the course materials) and once before the last exam at the end of the semester (after the students had exposure to the course materials). This exposure to course materials was a category variable (termed as TREATMENT) having two levels: (1) pre-exposure (termed as PRE) and post-exposure (termed as POST). The unit of analysis was the student.

Variables and their Operationalization

Relationship between site and thermal comfort (SITE): It is a dependent variable related to the perceptual importance of learning objective (1), measured on a Leikert-like scale ranging from 1 to 7.

Heat gain and heat loss analysis (HGHL): It is a dependent variable related the perceptual importance of learning objective (2), measured on a Leikert-like scale ranging from 1 to 7.

Equipment selection (EQUIP): It is a dependent variable related to the perceptual importance of learning objective (3), measured on a Leikert-like scale ranging from 1 to 7.

Duct and register sizing (SIZE): It is a dependent variable related to the perceptual importance of learning objective (4), measured on a Leikert-like scale ranging from 1 to 7.

Integration of HVAC systems with other building sub-systems (INTEGRATE): It is an independent variable related to the perceptual importance of learning objective (5), measured on a Leikert-like scale ranging from 1 to 7.

Exposure to course materials (TREATMENT): It is an independent category variable related to the level of the students to subject areas covered by the course as a whole. Level before the exposure of the students to course materials was labeled PRE and that after the exposure of the students to course materials was labeled POST.

Overall importance of the course (OVERALL): It is an independent variable that measures the perceived overall importance of the course as a whole by the student. It was measured on a Leikert-like scale ranging from 1 to 7.

Results

Analysis

The data was analyzed to find out (1) whether a relationship existed between overall perceptual importance of the course and the learning objectives, both before the course was taken and after completion of the course, and (2) whether there was a perceptual difference about the learning objectives between before and after taking the course.

It was important to find out whether the individual course objectives (SITE, HGHL, EQUIP, SIZE, and INTEGRATE) were relevant to the course as whole (OVERALL) as perceived by the students. It was also important to find out whether the level of exposure to the course materials (TREATMENT) made any difference. In order to find out whether a relationship existed between the individual course objectives and the course as whole, it was decided to analyze the data using General Linear Model. Following models were used for the analysis:

$$\text{SITE} = \beta_0 + \beta_1\text{OVERALL} + \beta_2\ \text{TREATMENT} \quad (1)$$
$$\text{HGHL} = \beta_0 + \beta_1\text{OVERALL} + \beta_2\ \text{TREATMENT} \quad (2)$$
$$\text{EQUIP} = \beta_0 + \beta_1\text{OVERALL} + \beta_2\ \text{TREATMENT} \quad (3)$$
$$\text{SIZE} = \beta_0 + \beta_1\text{OVERALL} + \beta_2\ \text{TREATMENT} \quad (4)$$
$$\text{INTEGRATE} = \beta_0 + \beta_1\text{OVERALL} + \beta_2\ \text{TREATMENT} \quad (5)$$

Where β_0 = intercept and β_1, and β_2 = regression coefficients.

The results of the analyses are shown in Tables 2, 3, 4, 5, and 6.

Table 2. General Linear Model analysis of SITE

Variable	Intercept	Regression Coefficient	t	$p<\lvert t\rvert$	Critical Value of $\lvert t\rvert$
Intercept	3.68		10.13	<0.001	2.02
OVERALL		0.40	3.48	0.001	
TREATMENT		0.01	0.025	0.98	
F-value of the Model = 12.21	p>Model F=< 0.0001	Model R^2 = 0.25 Adjusted model R^2 = 0.23			

Table 3. General Linear Model analysis for HGHL

Variable	Intercept	Regression Coefficient	t	$p<\lvert t\rvert$	Critical Value of $\lvert t\rvert$
Intercept	1.38		3.78	<0.001	2.02
OVERALL		0.55	4.71	<0.001	
TREATMENT		1.19	3.19	0.002	
F-value of the Model = 54.76	p>Model F=< 0.0001	Model R^2 = 0.59 Adjusted model R^2 = 0.58			

Table 4. General Linear Model analysis for EQUIP

Variable	Intercept	Regression Coefficient	t	$p<\lvert t\rvert$	Critical Value of $\lvert t\rvert$
Intercept	0.49		1.59	0.116	2.02
OVERALL		0.70	7.11	<0.001	
TREATMENT		1.38	4.41	<0.001	
F-value of the Model = 116.81	p>Model F=< 0.0001	Model R^2 = 0.76 Adjusted model R^2 = 0.75			

Table 5. General Linear Model analysis for SIZE

Variable	Intercept	Regression Coefficient	t	$p<\lvert t\rvert$	Critical Value of $\lvert t\rvert$
Intercept	0.64		2.08	0.041	2.02
OVERALL		0.71	7.21	<0.001	
TREATMENT		0.82	2.62	0.011	
F-value of the Model = 87.36	p>Model F=< 0.0001	Model R^2 = 0.70 Adjusted model R^2 = 0.69			

Table 6. General Linear Model analysis for INTEGRATE

Variable	Intercept	Regression Coefficient	t	$p<\|t\|$	Critical Value of $\|t\|$
Intercept	0.95		2.88	0.005	2.02
OVERALL		0.64	6.08	<0.001	
TREATMENT		0.62	1.82	0.070	
F-value of the Model = 87.36	p>Model F=< 0.0001	Model R^2 = 0.61 Adjusted model R^2 = 0.59			

In order to find out whether there was a perceptual difference of the importance of course learning objectives between before and after taking the course, a pair-wise comparison of the mean scores of PRE and POST levels was carried out. This was done by doing a simple t-test of paired samples (see Table 7).

Table 7. Comparison of perceptual importance of mean scores of learning objectives

Learning objectives		TREATMENT		t	$p<\|t\|$
		Mean score (PRE)	Mean score (POST)		
1	SITE	4.71	5.16	3.61	0.001
2	HGHL	2.87	5.31	8.88	<0.001
3	EQUIP	2.38	5.36	10.08	<0.001
4	SIZE	2.56	5.00	10.14	<0.001
5	INTEGRATE	2.69	4.77	8.79	<0.001

Interpretations

An important measure employed in statistical model analysis is coefficient of determination or R^2 value. It is used to assess how well a model explains and predicts future outcomes and is indicative of the level of explained variability in the model. The coefficient, also commonly known as R-square, is used as a guideline to measure the accuracy of the model. If there is a perfect relation between the dependent and independent variables, R^2 is 1. In case of no relationship between the dependent and independent variables, R^2 is 0. Predictive efficacies of the models, except for equation (1), were found to be moderately high, the adjusted values ranging from 0.58, and to 0.75.

The results (Tables 2 to 6) indicate a high F-value for all the models used for statistical analysis. It was found to be statistically significant at less than the 0.0001 level for all the models. This offers evidence that a relationship exists between the course learning objectives and at least one of the dependent variables included in the models. The results indicate that all learning objectives were related to the overall perceptual importance of the course at the level of significance of 0.001 or less.

The results (Table 7) also show that there was a perceptual difference of the importance of course learning objectives between before and after taking the course. The scores for all the learning objectives were significantly higher after a student had taken the course at the level of significance of 0.001 or less. That means that the perception of the students about all the learning objectives changed significantly after completion of the course.

Conclusions

The results of the statistical analysis indicate that student perception of the importance of all five learning objectives of a course on environmental control systems, taught at a university in Texas, has a statistically significant relationship with their perception of overall importance of the course. The results also provide evidence that their perception of the importance of all the course learning objectives changed significantly from pre- to post-course taking. The findings, therefore, confirm that the learning objectives of the course under study are important, at least perceptually, in terms of providing help to the students both academically and professionally.

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