

THREE DIMENSIONS OF THE ONLINE COURSE EVALUATION INSTRUMENT IN POSTSECONDARY EDUCATION

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ABSTRACT

The purpose of this study was to detect dimensions underlying online course structures in order to develop an inventory of online course evaluation at the postsecondary level. The indicators comprising the inventory were derived from a review of the literature and input from two consultant subject matter experts (SMEs). The four SMEs independently rated the similarity and dissimilarity of indicators by making pair-wise comparisons of the indicators utilizing multidimensional scaling (MDS).

The study had six distinct stages. The MDS study indicated the three-dimensional solution as the appropriate model of the online course structure. The three dimensional solution indicated .24222 of the fit values of STRESS and seventy-four percent of the variance in the similarity data matrix.

The outcome of the study was the development of a resource of validated evaluation indicators clustered by dimensions that could be used in the creation of instruments by instructors for use in the evaluation of online courses in assessing the quality of their courses at the postsecondary level.

KEY WORDS

Multidimensional scaling, evaluation, online course, postsecondary level, dimensions.

1. Introduction

This study is one of the validation research processes used to develop an instrument to evaluate online courses in the postsecondary education. The validation study applicable to factor analysis usually has four stages [1]: Stage I involves item development; stage II involves item validation by experts; stage III includes factor analysis, and stage IV includes item revisions and completeness of the inventory.

The current study, which was applied to multidimensional scaling, included stage I and II of the validation study processes. This study was further divided into six study processes. The researcher identified and developed

indicators and the subject matter experts validated the indicators on the proximity between them. In the current study, the items are called indicators because they are still in the process of being validated. This study is applied to multidimensional scaling to examine the content validity of the online course evaluation inventory. This multidimensional scaling study detected the underlying dimensions of the online course structure by clustering the indicators and determined how well the indicators represented each dimension. The dimensions are the evidence of the content validity. This multidimensional scaling study is followed by a factor analysis study in the series of the validation study in order to develop an inventory for online course evaluation in postsecondary education.

Statement of the Problem

The number of postsecondary educational institutions implementing online learning continues to increase. With the increases, concerns regarding the quality of online courses arise. A major concern is the need for evaluation strategies that assess the effectiveness of the online courses [2]. These concerns have centered on (a) the importance of knowing which online instructional designs maximize student learning, (b) how best to structure content for online delivery, and (c) how to evaluate student performance in a manner that is valid and reliable while also providing evidence on how to improve the quality of online learning [3]. Given the growth in online instruction and the varied circumstances under which online courses and degrees are offered, evaluation instruments and processes are needed to ensure high quality instruction. As technology has improved, the focus has been on creating courses and on developing the capacity to employ more advanced features in offering online instruction. Evaluation has tended to be instructor driven and focuses on the perceptions of students and student outcomes. Less attention has been given to empirical data determining the factors that contribute to effective instructional designs and the elements of online instruction that maximize student outcomes [4]. A research base for verifying the quality of online instruction at the postsecondary level is beginning to

emerge. For example, a qualitative analysis of student online learning experience was explored [5] as well as a heuristic formative evaluation of an online course [6]. In addition, Stewart [1] conducted a study on the "Development and validation of an instrument for student evaluation of Web-based instruction." The paucity of research has focused on development and evaluation of online instruction features. Ciavarelli [3] created a plethora of evaluation items as an e-learning assessment framework. However, the work was not validated through any field research and exploratory factor analysis was not applied.

Purpose of the Study

The current study is one of the validation studies used to develop the online course evaluation inventory. The purpose of this study was to detect dimensions underlying online course structure and determine how the dimensions would be configured. The dimensions are the evidence of the content validity of the online course evaluation inventory. Identifying the dimensions pertinent to the online instruction is to be purported in order to guide the directions of the effective implementation of the online instruction. This study examined the proximities between indicators identified as being applicable to assessing online courses at the postsecondary level.

The intent was to identify and validate indicators representing the main components of asynchronous online instruction at the postsecondary level. The indicators represent the features of e-learning warranting consideration in the evaluation of online instruction. This study explored observed proximities of similarities or dissimilarities between the investigated items. The study resulted in the development of a repository of validated indicators organized on the basis of similarity.

2. Body of Paper

The study was designed to identify components of online instruction at the postsecondary level, which represent indicators warranting consideration when evaluating online instruction. Once identified, the indicators were subjected to validation by two subject matter experts (SMEs) and framed as statements appropriate for use in multidimensional scaling (MDS). An online multidimensional scaling instrument was developed to accommodate the process of applying MDS to large numbers of comparisons. A panel of four subject matter experts was engaged to determine the similarity and dissimilarity of indicators by making pair-wise comparisons of the indicators utilizing multidimensional scaling techniques.

The research was conducted in six stages. Each stage will be discussed individually.

Stage I. Procedures for the Literature Search and Identification of Indicators for MDS Instrument.

Educational databases, including the Educational Resource Information Center (ERIC) 1966 to the present, Dissertation Abstracts international (1962 to present), and Wilson Omnifile (1994 to present) were searched using key terms such as (a) online course evaluation, (b) e-learning, (c) online instruction, (d) quality of e-learning, (e) multidimensional scaling, (f) validation of e-learning, (g) and e-learning in accreditation. Traditional review strategies for analyzing secondary sources were also employed in the literature review process. Additionally, evaluation instruments developed by postsecondary institutions and published on websites or in the literature were included in the literature review.

Personal interviews were also conducted with individuals experienced in teaching online courses. E-learning Assessment Framework (containing sixty items, developed by Ciavarelli [3]) contributed to identifying and developing the indicators for this study. Email correspondences with Dr. Ciavarelli provided in-depth knowledge of item validation. The content validity study by Sireci, Robin, Meara, Rogers, and Swaminathan [7] that applied MDS provided insights into how to design the MDS study. Based on the result of the literature review, the researcher developed an inventory of statements, which included 90 indicators applicable to the evaluation of online instruction at the postsecondary level, categorized into seven topical themes. They were:

- Teaching Effectiveness
- Learning Effectiveness
- Instructional Design
- Interactivity
- Informational Resource
- Assessment
- Technological Support

These indicators and categories represented the data provided to the SMEs in determining the final indicators and the language to be used in framing the indicators for inclusion in the multidimensional scaling implemented in Stage II.

Stage II. Procedures for Preparing the Indicators for Inclusion in the MDS Instrument

Stage II involved two subject matter experts reviewing and validating the 90 evaluation indicators identified in Stage I and reaching consensus on duplication, independence, and comprehensiveness of the indicators and their appropriateness for inclusion in the MDS instrument. They had four face-to-face meetings, which resulted in 99 indicators of 11 topics, illustrated in table 1.

Table 1
Revised Topics and Number of Indicators by Subject Matter Experts

Topics	No. of Indicators
This Course was Effectively Designed	6
User Interface	9
Navigation	6
Getting Started	6
Technical Assistance	4
Topics	No. of Indicators
Course Management (instructor)	10
Course Management (student)	7
Universal Design	7
Communication	8
Online Instructional Design	21
Content	14
Total: 11 topics	99

Stage III. Procedures for Developing the MDS Instrument

In an effort to reduce the amount of time required by SMEs--in MDS making the pair-wise comparisons of the 99 indicators--a software system was developed by the e-Learning Design Lab (eDL) at the University of Kansas. The system was designed as a program that could be repeatedly used in subsequent studies. The program was designed so that the respondents could (a) enter their user name and password; (b) start, stop, and return later from any computer; and (c) directly access the last indicator to which they had responded.

The categorizing process had been used only to stimulate the considerations of a broad range of indicators applicable to the evaluation of online instruction at the postsecondary level. In responding to the indicators on the instrument, the indicator being compared to all other indicators was presented at the top of the screen with other indicators appearing one at a time below the indicator being compared.

Once an indicator was compared to all others, a new indicator appeared to be repeated in the comparing process. The new indicator appeared in a different color the first time it was presented. Each comparison was made on a nine-point scale with 1 representing the most extreme degree of dissimilarity and 9 representing the most extreme degree of similarity. With 99 indicators in the MDS instrument there were a potential of 4,851 judgments to be made in the pair-wise comparisons ($[99*98]/2$). The program allowed the respondents to monitor where they were in the pair-wise comparison process. For example, if 2,200 comparisons had been made the number 2,200 out of 4,851 would appear in the top right hand corner of the screen.

Stage IV. Procedures for Data Collection

A panel of four subject matter experts (SMEs) served as judges in completing the MDS Instrument. This involved making 4,851 ($[99*98]/2$) pair-wise comparisons of all indicators with each other in order to determine the proximity among the indicators [7].

Stage V. Procedures for Responding to the Online MDS Instrument

Data collection occurred during the fall semester of 2005.

Stage VI. Procedures for Data Analysis

MDS provides a visual, mathematical representation of the detected distance between items in a spatial mode ([8], [7], [9]). Distance between two items in a spatial fashion is an inference for "the perceived relatedness" between items. "This spatial representation, which shows the location of each items of a category, is called a configuration, and is the most important result produced by MDS" ([9], p. 140). Sireci et al. [7] reported that "each dimension in an MDS solution corresponds to an attribute or characteristic of the objects as are necessary to adequately represent the similarity ratings" (p. 83).

A Replicated MDS (RMDS) model was used for this analysis. The RMDS model was implemented in the ALSCAL algorithm in SPSS, version 14 [10]. The statistic results of RMDS can be obtained by exploring a MDS on each of the data matrixes separately. The replicated distance formula was employed to determine the proximities between indicators and the judges' preferences.

The purpose of multidimensional scaling is to detect the latent structure representing the defining characteristics of the mode in the proximity data matrix. The judges of the pair-wise comparison identify a pair of coordinates "so that the distances among stimulus points accurately represent the proximities among stimuli" ([9], [11], p. 326).

The fundamental form of multidimensional scaling is realized when there is at least a dissimilarity or similarity data matrix. Classical multidimensional scaling (CMDS) uses the Euclidean distance model to construct dissimilarity or similarity. The mathematical models for a proximity data matrix include:

$$d_{ij} = \sqrt{\sum (x_{ia} - x_{ja})^2}$$

$$d_{ij} = \left[\sum_a |x_{ia} - x_{ja}|^p \right]^{1/p}$$

$$r(\delta_{ij}) = d_{ij} + e_{ij}$$

Where the distance d_{ij} is the distance between points i and j and "where x_{ia} states the coordinate of point i on dimension a " ([11], p. 327, [12]).

Replicated multidimensional scaling (RMDS) allows the proximity ratings of several matrices at the same time. RMDS and CMDS employ the Euclidean distance model.

RMDS Model Fit to the Data

The data analysis applied two-to-six dimensional MDS solutions. In order to select the most fitting Model-data fit, (a) the fit values of STRESS and R-squared were examined, and (b) the interpretability of the solution was also used. The rationale for this is in accordance with the work of Sireci and Davison [11].

The primary criteria to determine dimensionality are numerical fit values. They are STRESS and R-squared for different dimensional solutions. Generally, these statistical fit values indicate the goodness of fit, or how well the dimensionality fits to the data [11]. Minimal STRESS is a criterion used to get the best MDS solution for helping select among competing MDS solutions. It is also defined as a measure of the overall magnitude of the difference between the inter-stimulus distances (MDS solution) and the original (transformed) dissimilarity data. The numerical index of STRESS ranges from 0, indicating the best possible fit, to 1, indicating the worst possible fit. For example, STRESS of 0 indicates the stimuli in the pair-wise comparison are similar to each other in the dimensional configuration [11].

R-squared is perceived as “the amount of variance” in proximities in the data matrix, or “the dependent variables”. The higher numerical R-squared index indicates a better fit of the dimensionality ([11], [9], p. 153).

This MDS study indicated the three-dimensional solution as the appropriate model of the online course structure. The three dimensional solution indicated .24222 for the fit values of STRESS and .74 for R-squared, the variance in the similarity data matrix. Table 2 illustrates the numerical fit indexes. They are (a) the fit value of STRESS and (b) the value of R-squared (R^2).

Table 2
The Numerical Fit Indexes from RMDS Solution

# of Dimensions in Solution	STRESS	R^2
• 6	.13004	.82760
• 5	.15125	.81429
• 4	.19424	.78116
• 3	.24222	.73505
• 2	.36251	.57147

Figure 1 visually represents the data of the numerical fit indexes from RMDS solutions in Table 2.

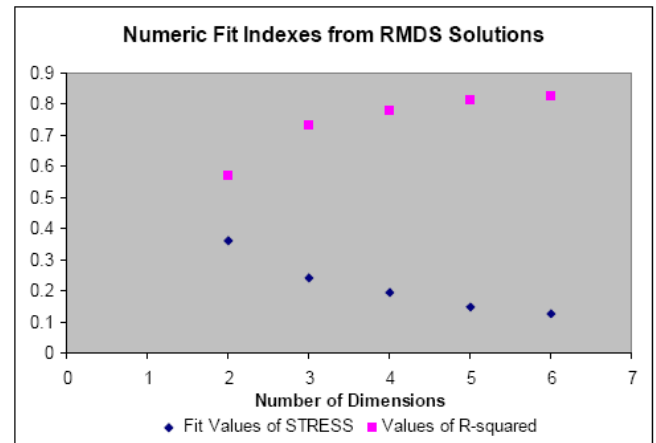


Figure 1. The numerical fit indexes from the RMDS solution.

The numerical indexes are (a) the fit values of STRESS and (b) the numeric values of R-squared. The plot indicates the three dimensional solution is the most appropriate model for this study in which the first biggest elbow appears.

Interpreting the Dimensions

The visual and statistical interpretations were employed to label and give meanings to the dimensions and indicator clusters. Two consultant SMEs labeled the three dimensions by using visual and statistical results. The dimensions were labeled Accessibility, Adaptability, and Clarity of Communication. The researcher interpreted them.

The Accessibility Dimension (Dimension 1)

The two SMEs labeled dimension 1 as the “Accessibility” dimension and defined it as including indicators that emphasize attributes of online instruction that enhance access to courses and to features within online instruction. Navigation options, required technical skills, control of font size and related screen management capabilities combined with the ability to easily progress through the instructional features are central to the dimension of accessibility. The Accessibility dimension (dimension 1) represents cognitive aspects of the online course structures. It mainly addresses the user interface used as learner friendly instructional strategies in the e-learning environment.

The Adaptability Dimension (Dimension 2)

The two consultant SMEs labeled dimension 2 as the “Adaptability” dimension, and defined it as including indicators that allow the learner to make modifications that meet their instructional preferences. These include indicators that give the learner more control over the presentation features, more choices on how content is managed, and indicators that offer more options for understanding the content and organization of the course. Like the Accessibility dimension, the Adaptability dimension (dimension 2) also represents cognitive aspects

of online course structures. It mainly indicates the user interface strongly associated with learning contents in the e-learning environments.

The Clarity of Communication Dimension (Dimension 3)
The two consultant SMEs labeled dimension 3 as the “Clarity of Communication” dimension, and defined it as including the relevance and clarity of the instruction including the use of explicit benchmarks, requirements and expectations.

The Clarity of Communication dimension (dimension 3) represents the teaching aspects of online course structures. It indicates online instruction as the means of the effective conveyance of information. It addresses how well: (a) the learning materials are presented, (b) the learning contents are delivered, and (c) the learning expectations are conveyed.

The study results in four distinctive clusters of indicators in each dimension. The four clusters are the same for each dimension but the coordinates of the indicators within each cluster vary slightly. Two SMEs also labeled the clusters based on their representative characteristics and the researcher interpreted them. The names of the clusters are (a) Contextual Accommodation, (b) Instructional Access, (c) Guided Learning, and (d) Organizational Clarity.

The Contextual Accommodation Cluster

The “Contextual Accommodation” cluster indicators represent teaching aspects of the instructional context. The indicators address what students learn in the learning contexts. The learning objectives, critical learning topics, learning activities, study guidelines, and universal design are included. The instructor’s general roles related to learning materials, feedback, and instruction in a learning context are also indicated. The Contextual Accommodation cluster loads very low on dimension 1, moderately high on dimension 2, and in the middle on dimension 3.

The Instructional Access Cluster

The “Instructional Access” cluster indicators represent teaching aspects of online course structures. It emphasizes learners’ instructional accessibility, indicates flexibility of learners’ academic ability and preference, learner centered learning activity, the usability of the instructional archive, and the user interface. The indicators address the e-learning strategies. The Instructional Access cluster loads middle on dimension 1, very low on dimension 2, and moderately low on dimension 3.

The Guided Learning Cluster

The “Guided Learning” cluster indicators represent teaching aspects of online course structures. It addresses the instructional information about course expectations, instructional goals, strategies, and evaluation. It also indicates the clarity of communications, including a detailed syllabus, benchmarks, and performance

expectations. The Guided Learning cluster loads moderately high on dimension 1, middle on dimension 2, and high on dimension 3.

The Organizational Clarity Cluster

The “Organizational Clarity” cluster indicators represent the cognitive aspects of online course structures. It addresses the effectiveness of the user interface. The indicators address (a) visual and aural effectiveness, (b) the universal design for learning, (c) instructional technical support, and (d) the effectiveness of the computer-human interaction.

The Organizational Clarity cluster loads high on dimension 1, moderately high on dimension 2, and very low on dimension 3.

Figure 2 illustrates a configuration of the three-dimensional subspace formed by dimensions 1, 2, and 3. The configuration of the three-dimensional subspace presents the correlations of clusters and dimensions.

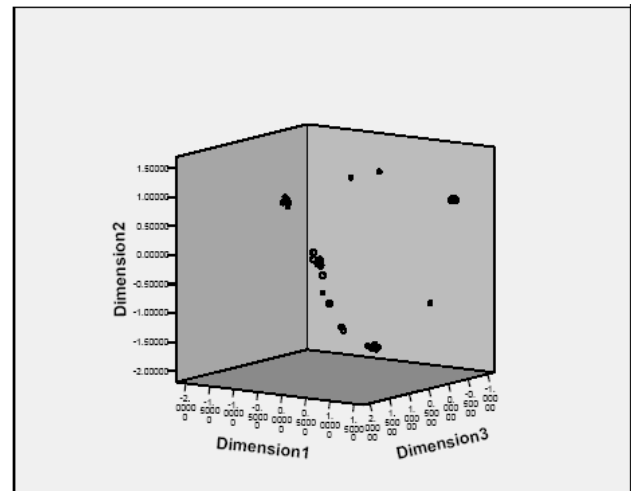


Figure 2. The three-dimensional indicator subspace for dimensions 1, 2, and 3.

3. Conclusion

The detected dimensions and clusters indicated that e-learning “pedagogy includes teaching methods related to the presentation of experiences, engagement of learners, reinforcement, motivation, organization of teaching tasks, feedback, evolution, and curriculum integration” ([13], p. 40). The dimensions also suggested that the e-learning environment should support e-learners in three categories in order to maximize the effectiveness of online courses by maximizing the accessibility, adaptability, and clarity of communication. The three categories are ([14], [15]):

- Cognitive: supporting and developing learning through the most effective user interface, and mediation of the standard and uniform elements

of course materials and learning resources for individual students.

- Affective: providing an environment that supports students through social strategies and teaching aspects.
- Information management: keeping students updated and cognizant regarding instruction, and being overall student-friendly in the process.

Some organizations developed guidelines focused on cognitive, affective and information management. The authors, the publishing dates, the names, and the URLs of the guidelines are listed in Table 3.

Table 3
The Authors, the Publishing Dates, the Names, and the URLs of the Guidelines

Authors, Date	Name	URL
WCET, 2000	Best practices for electronically offered degree and certificate programs	http://www.wcet.info/resources/accreditation/Accrediting%20-%20Best%20Practices.pdf
NEA & Blackboard Inc., 2000	Quality On the Line: Benchmarks for Success in Internet-Based Distance Education	http://www.ihep.org/Pubs/PDF/Quality.pdf
Chickerign & Ehrmann, 1996	The seven principles of good practice	http://www.tltgroup.org/programs/seven.html
ADEC, 1997	Guiding principles for distance learning and Teaching	http://www.adec.edu/admin/papers/distance-learning_principles.html
Penn State University, 1999	An emerging set of guiding principles and practices	http://www.outreach.psu.edu/DE/ide/guiding_principles/

Limitations of the Study

This study had 4,851([99*98]/2) pair-wise comparisons. The reviewers reported that the 4,851 pair-wise comparisons took between 12 and 14 hours and were done in multiple settings. A larger number of SMEs participating as judges may have provided additional

comprehensive information about the dimensionalities and their characteristics. It also may have increased the power of the analysis. However, these limitations did not affect the overall results of this study.

Suggestions for the Further Research

This study has resulted in the identification of validated indicators that can be transformed into item scales and subscales that will serve to evaluate the effectiveness of several aspects of e-Learning instruction. The instruments that can be derived from this study will be used to evaluate productivity and processes in the rapidly evolving discipline of e-learning. If widely adopted, the impact of these instruments on the design and quality of e-learning will be significant. Because there are several dimensions and clusters of indicators, the instruments can be used to pinpoint various aspect of e-learning and thus will likely be used in a formative way as online courses and instructional strategies are refined. The instruments will also continue to evolve as they are applied to different e-learning problems and populations of learners. The dynamic nature of these instruments is especially appropriate in a discipline that is changing rapidly. Even so, some of the dimensions and clusters are tied more to the pedagogy of e-learning than to the technology implementation. The data from this study should stimulate additional research targeted to evaluating the overall quality of online courses, the effectiveness of specific design features, and the processes employed in teaching online courses. Student perceptions, while valuable, do not always address elements of design that contribute to the quality of online courses. Online instructors may evaluate their courses and use the data in a formative manner to improve their online instruction, but it is also important for online courses to be evaluated from a structure and design perspective. This study offers direction beyond student perceptions and outcome measures. The dimensions and clusters provide information on a wide array design elements. The model employed can also be replicated with a broader coverage of the major conditions that contribute to the quality of online instruction at the postsecondary level. A preliminary phase of this study involved the SMEs classifying the ninety-nine indicators (according to their judgment) as to how they may eventually sort out in the MDS analysis. When data derived from the four SMEs acting as judges in response to the MDS instrument were analyzed the dimensions and the clusters varied greatly from the pre-classification of the indicators. The resulting dimensions and clusters are far more generalizable in terms of the sub-scales that can be developed than the classification done prior to the study. The implication is that the MDS process was effective in determining relationships among indicators in a manner that is more effective than applying a general logic approach.

Implications

This validation study determined the relationship of evaluation indicators developed to measure the intended

outcome of online courses. The dimensions of Accessibility, Adaptability, and Clarity of Communication combined with the following four clusters (a) Contextual Accommodation, (b) Instructional Access, (c) Guided Learning, and (d) Organizational Clarity provide a construct for further research and instructional development in evaluating online courses at the postsecondary level. The construct of the dimensions addresses the important latent components or elements of online learning that can be emphasized in instructional design. This study also emphasized indicators that related to the interactions between the learner and instructor or between the learner and computer in online courses within each dimension.

This study is significant because (a) there has been limited research reflecting the perspectives of subject matter experts' on indicators of online course evaluation, (b) there is a paucity of validation studies of online course evaluation indicators, (c) the comprehensive literature review for this research developed an inclusive and extensive pool of indicators, and (d) the dimensions and clusters provide a construct that can be used by online course instructors to develop instruments for evaluating their course constructs or structures.

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