Measuring Constructivist Learning EnvironmentsÉ in Tertiary Education

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ABSTRACT

This paper reports an attempt to validate the factorial structure of the Constructivist Learning Environment Survey (Taylor and Fraser, 1991) at the tertiary level using confirmatory factor analysis. The CLES was originally developed and validated for secondary school settings.

The data comprised responses from 335 students enrolled in two subjects offered by the Faculty of Education of a large metropolitan Australian university. Goodness©of©fit indexes suggested the scale was unsuitable for tertiary students. A new scale, the Measure of Constructivist Learning Environments, was found to be more suited for this purpose.

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Constructivist Theory of Learning

The familiar, traditional transmission model of teaching, whereby information is transferred from the teacher to the learners, and in which the learners play passive roles, is gradually being replaced by constructivist learning theory. This empasizes that learners actively construct knowledge for themselves by forming their own representations of the material to be learned, selecting information they perceive to be relevant, and interpreting this on the basis of their present knowledge and needs. In this theory, learners assume more active and interactive roles (Dart, 1994; King, 1993; Prawat and Floden, 1994; Zell and Malacinski, 1994).

Thus, in the transmission model of teaching, the teacher is the focus, whereas in constructivist theory of learning the learner is the focus. This is how it should be, for in constructivist learning, the learning drives the teaching, as adjustments need to be made in the teaching role to enable learners to recognize their own relevant ideas and beliefs; evaluate these ideas and beliefs in terms of what is to be learned and how this learning is intended to occur; and decide whether or not to reconstruct these ideas and beliefs. The teacher's role therefore includes helping learners identify their beliefs and working with them to master impediments to understanding. This can be achieved through facilitating student-student and student-teacher interaction; by using reflective feedback to enhance the nature of discussions; by providing critical feedback related to learners' contributions; and by challenging learners' naive conceptions. Thus, the teacher becomes a facilitator of learning rather than a giver of information.

If learning with understanding, characterized by the making of connections: connections between aspects of the new material, connections between new material and prior knowledge, and connections between informal and formal knowledge, is a desired outcome; rather than rote learning and regurgitation of information, then replacement of the transmission model of teaching by constructivist teaching needs to be hastened.

Many writers (Baird, 1991; Brooks, 1990; Brown, 1988; Dart, 1994; Jonassen, 1994; King, 1993; Prawat and Floden, 1994; Resnick, 1987; Tobin, 1990; Zell and Malacinski, 1994) emphasize the importance of social interaction in bringing about changes in understanding. The primacy of collaborative learning is stressed: peer collaboration is essential to the learning process as learners construct meaning and understanding through active participation and sharing of knowledge (Resnick, 1987); a change in understanding is more likely to occur through social interactive methods that require learners to explain, elaborate, and argue their position to others (Brown, 1988); constructivist environments should support collaboration among learners and with the teacher who failitates social negotiation (Jonassen, 1994; and negotiation, as a process of overcoming obstacles to understanding, is seen as a collaborative activity engaged in both by teacher and students (Prawat and Floden, 1994). Collaborative learning groups provide opportunities for learners to examine and refine their understandings. What is important is that "...opposing views become alternatives to be explored rather than competitors to to be eliminated" (Roby, 1988, p. 173). These activities also necessitate the exercise of reflection and metacognition, as well as the acceptance of self-responsibility for learning (Biggs and Moore, 1993). From a constructivist viewpoint, learners must have control over their own learning, as the responsibility for learning and sense-making resides with individual learners.

Measuring Learning Environments

There is evidence that how students perceive their learning environments has a significant influence on the quality of their learning outcomes (e.g. Dart, 1994; Doyle, 1977; Fraser, 1989; Ramsden, 1992; Trigwell and Prosser, 1991). There has been considerable research activity on student perceptions of their learning environments in primary, secondary, and teriary education reviewed for example in Brown and Atkins (1988), Fraser (1989, 1991), Fraser and Walberg (1991), Marsh (1987), and Ramsden (1992). The major aim of the studies reviewed was to provide information that might be used to improve the quality of student learning and directly or indirectly, to improve the quality of teaching.

A key feature of recent classroom environment instruments is that they have separate versions which measure student perceptions of preferred classroom environment and actual classroom environment. The preferred versions deal with goal and value orientations and measure perceptions of the classroom environment ideally liked.

Generally, items in classroom environment instruments are worded in such a way as to measure an individual student's perceptions of the class as a whole. However, Fraser, Giddings, and McRobbie (1991) developed a personal form of the Science Laboratory Environment Inventory which parallels the class form. This allows the measuring of an individual student's perceptions of his or her own role within the classroom.

Measuring Constructivist Learning Environments

To date, there has been only one general classroom environment instrument developed to measure the extent to which a particular classroom environment reflects a constructivist philosophy. This is the Constructivist Learning Environment Survey (CLES) (Taylor and Fraser, 1991). It has a personalized response format.

After changing the word "teacher" to "lecturer" and modifying the wording of some items to make them more relevant for university students, examination of the items in the CLES indicated that it might be inappropriate to use at the tertiary level. The items did not seem to focus sufficiently on constructivist teaching/learning strategies, and a number of items were simply the negative of others. Consequently, on the basis of qualitative analysis of responses by 154 Post Graduate Diploma of Education students to open-ended questions relating to their learning (Dart, 1992), and theory, the Measure of Constructivist Learning

Environments (MCLE) was developed . This instrument has two forms, preferred and experienced, similar to the CLES, and the items are written to determine students, perceptions of their role within the classroom. Its use with a small class of tertiary students is reported in Dart (1994). The reason for developing this instrument was to construct a concise measure of student perceptions of constructivist learning environments that academic teachers could use either to determine student preferences for a constructivist approach to learning (preferred form), or identify ways in which they may need to change their teaching to provide a constructivist learning environment(experienced form).

Development and Validation of Scales

Traditionally, most researchers have used exploratory factor analysis (EFA) to develop scales . However, in more recent times, confirmatory factor analysis (CFA) has been used more frequently. The literature on measurement has proposed the use of CFA to validate the presence of factor structures (Byrne, 1991; Jreskog and Srbom, 1989; Long, 1983). In CFA, on the basis of theoretical expectations, a priori factors are specified and techniques seek to optimally match the observed (measured) and theoretical (latent) factor structures for the given data set to determine the goodness-of-fit of the hypothesized factor model.

Various indicators can be used to assess the goodness-of-fit of the data to the proposed model. Some of these include the Goodness-of Fit Index (GFI), the Adjusted Goodness-of-Fit Index (AGFI), the Root-Mean-Square-Residual (RMSR), Chi-Square/Degrees of Freedom df ratio. It is generally accepted that values of AGFI>0.90 represent a good fit (Reynolds and Walberg, 1991); a df ratio <5 represents a reasonable fit (Marsh and Hocevar, 1985); and a RMSR<0.05, an acceptable fit (Coovert, Penner, and MacCallum, 1990). The Chi-Square test is extremely sensitive to sample size and will almost always reject a model on statistical bases (Bentler, 1990), that is Chi-Square often attains significance when there are relatively unimportant differences in the latent and measured variables. As well as these indicators that are provided by the LISREL program, two other frequently used indexes are the Relative Noncentrality Index (RNI) and the Tucker-Lewis Index (TLI), both of which avoid problems resulting from sample size, however, the TLI penalizes model complexity for estimating more parameters. Marsh (1991) suggests that a commonly accepted guideline for goodness-of-fit using relative indexes, such as the RNI

and the TLI, is 0.90.
A value of the index of 0.90 can be considered as explaining approximately 90% of the covariation among the measured variables (Marsh, 1991). The RNI and TLI are based on the difference between the proposed model and an alternative model such as a "null" model in which the a priori specification is made that all observed variables are unrelated, that is, the items on the scale have no loadings on any factors.

Focus of This Study

The purpose of this study is to determine the adequacy of the CLES and the MCLE to measure tertiary students' preferences for a constructivist learning environment through using confirmatory factor analytic techniques.

Method

Sample

The sample used in this study included 335 students enrolled in courses within the Faculty of Education of a large metropolitan university. There were 50 males and 285 females.
One hundred were enrolled in the Graduate Diploma in Education (Pre-service), 116 in the Bachelor of Education (Primary), and 119 in the Bachelor of Education (Early Childhood). Two hundred and one students were 20 years of age or younger, 83 were aged between 21 and 25 years inclusive, 17 between 26 and 30 years inclusive, and 34 were older than 30 years.

Instrumentation

The CLES (Preferred Form) is a 28-item scale that has four subscales: Negotiation, Prior Knowledge, Autonomy, and Student-Centredness. Items on each subscale are rated by respondents on a 5-point Likert scale (5= very often, 1= never). The scoring direction is reversed for approximately half of the items.

The MCLE (Preferred Form) has eleven items that were constructed to measure three central features of a constructivist learning environment. These elements were Collaboration (4 items), Responsibility (3 items), and Autonomy (4 items). Respondents rate each item on a 5-point Likert scale (5= very often, 1= never). Four items have their scoring direction reversed.

Data collection

All students were studying a similar unit dealing with the psychology of learning and teaching, and tutors administered both the CLES and the MCLE during the

last hour of a tutorial session in the fourth week of semester.

Analysis

Burnett (submitted) compared the factor structures obtained with two large data sets using six factor analytic approaches to scale development. He recommended that when sample size does not permit cross-validation (under 350-400), a modified CFA is favoured over using theoretical EFA, even though they give similar structures, because error is measured. His modification procedure uses two criteria to refine the hypothesized measurement model. Firstly, items are deleted, using an iterative process, if their squared multiple correlation is less than 0.3, and secondly, when all squared multiple correlations are above 0.3, items which have an estimated change in lamda X of greater than 0.4 are deleted. The first criterion is used on the basis that if an item accounts for 30% or more of the variation in its latent variable then it is a worthwhile item. The second criterion is supported by Stevens' (1986) recommendation that a factor loading of 0.4 or greater accounts for a distinctive contribution of the item to the factor, as well as by the advice of

Comrey (1988), that any one item should be allowed to load on only one latent variable. When both criteria are satisfied a final analysis is computed. It should be noted that once the initial model is modified, the analysis becomes exploratory in nature.

Each item in the CLES and the MCLE was constrained to load only on the latent variable it was designed to indicate, and the respective measurement models for the CLES and the MCLE were analysed using the maximum likelihood estimate of parameters in LISREL 7 (Jreskog and Srbom, 1989).

Internal consistency (Cronbach reliability coefficient) was also determined for each subscale of the CLES and MCLE.

Results and Discussion

(a) CLES:

The results of the initial (pure) confirmatory factor analysis for the adapted CLES were:

GFI=0.68, AGFI=0.62, RMSR=0.11, df=5.94, RNI=0.57, TLI=0.53. After modification twelve of the original twenty-eight items remained (see Table 1). The goodness-of-fit indexes were: GFI=0.86, AGFI=0.78, RMSR=0.07, df=6.93, RNI=0.84, TLI=0.79.

The structural correlations between each latent variable (see Table 2)

indicated independence of all except for some degree of overlap between Negotiation and Prior Knowledge (phi=0.66). This correlation and the modification indices for the items of these subscales suggest that the subscales be combined and and a single factor investigated. Testing of this respecified model indicated a decrement in fit (GFI=0.84, AGFI=0.75, RMSR=0.08, df=8.00, RNI=0.80, TLI=0.74). Therefore, this model was rejected and the initial modified model was retained.

Estimates of factor loadings for the modified model are shown in Table 1. The estimations reflect complete standarization of the maximum likelihood solution. Thus the values correspond to typical factor loadings. These factor loadings are of the same sign and vary from adequate to high (0.56 to 0.94). Therefore, the hypothesized factors explain a moderate to high amount of variance of each item.

Reliability estimates generated by CFA are an indication of the reliability of each observed measure with respect to its underlying latent variable (see Table 1). These are given by the squared multiple correlation (R) for each observed variable and indicate the percentage of variation in an observed variable that is explained by the factor that it is intended to measure. Examination of Table 1 indicates that Item 2 (R=0.77), was the most reliable indicator for Negotiation, Item 5 (R=0.64) for Prior Knowledge, Item 10 (R=0.64) for Autonomy, and Item 12 (R=0.88) for Student Centredness. There are some items with R less than 0.5 (Items 1, 8, and 9), and while these values are still reasonable, they are suggestive of somewhat less reliability than are the other items.
The coefficient of determination is an indication of how well the observed variables,in conjunction, measure the latent variables together, that is, it is a generalized indicator of relibility for the entire measurement model (Byrne, 1989). In this case, it is 0.99, indicating the measurement model is very good.

Cronbach reliability coefficients for each of the subscales were: Negotiation, 0.78; Prior Knowledge, 0.60; Autonomy, 0.71; and Self Centredness, 0.80.

Enter Table 1 here

Enter Table 2 here

Results suggest that the measurement model for the adapted CLES does not provide a good fit to the data. After modification, entailing the loss of 16 items, the modified model provides only a moderate fit, even though the estimates of factor

loadings and reliability

in the CFA appear reasonably acceptable, as do the Cronbach alpha coefficients (except for Prior Knowledge).

(b) MCLE:

The results of the pure confirmatory factor analysis for the MCLE were: GFI=0.92, AGFI=0.88, RMSR=0.07, df=3.62, RNI=0.91, TLI=0.88. In the modification process, two items were removed leaving nine (see Table 3). The results for the modified model were: GFI=0.95, AGFI=0.90, RMSR=0.06, df=3.42, RNI=0.93, TLI=0.90.

Independence of the factors was confirmed by the structural correlations between them. These were all small (see Table 4).

The estimates of the factor loadings for the modified MCLE measurement model are presented in Table 3. They are of the same sign and range from adequate (0.46) to high (0.93). So a moderate to high amount of variance of each item is explained by the hypothesized factors.

The squared multiple correlations for each item (see Table 3) show that Item 1 (R=0.86) is the most reliable indicator of Collaboration, Item 4 (R=0.53) for Respopnsibility, and Item 7 (R=0.71) for Autonomy. Items 5, 6 , 8, and 9 had squared multiple correlations less than 0.5.

The coefficient of determination for this modified MCLE model was 0.99, indicative of a very good measurement model.

The reliability coefficients indicated by Cronbach for each of the subscales of the MCLE were: Collaboration, 0.77; Responsibility, 0.64; and Autonomy, 0.61.

The Cronbach coefficients for Prior Knowledge in the modified CLES and Responsibility and Autonomy in the MCLE are less than 0.65 and so are considered marginal, however, each of these subscales contain a relatively small

number of items and
Green, Lissitz, and Mulaik (1977) suggest that reliability estimates calculated in this manner are a function of the length of the test. Reliability estimates can be improved by increasing the number of items on a scale. It may not be appropriate to calculate alpha coefficients for scales developed using CFA, but because it is the norm people expect in evaluating scales, they are provided. The squared multiple coefficients attest to each

item's reliability and could be considered more powerful estimates because measurement error is considered, whereas alpha coefficients do not take measurement error into account.

Enter Table 3 here

Enter Table 4 here

The fit of the original MCLE was reasonable and much better than even the modified CLES. However, after modification with the resulting loss of two items, the fit improved, so that on consideration of the range of indexes evaluated, it can be claimed that this modified model provides a good fit to the data. As well, the factors were independent, and the estimates of factor loadings and reliability ranged from adequate to high.

Conclusion

The present study investigated the validity of an adapted CLES and the MCLE separately, for teriary students. CFA was used to validate the hypothesized factor structures and then a modified CFA approach was used to refine the items in each scale.

Even with adaptation of CLES items to the tertiary context, the modified CLES does not provide a satisfactory measure. Since it was not intended for this purpose specifically, this is not surprising. On the other hand, the modified MCLE provides a reasonably good fit and may be useful for the purposes for which it was developed, namely, a quick means for an academic teacher to (i) identify student preferences for using constructivist learning strategies and so be able to refine their teaching approach to accomodate these (preferred form), and (ii) determine how effectively they have used constructivist teaching strategies from the perspective of their students and make necessary adjustments (experienced form). However, the sex imbalance in the sample used here is a limitation in determining the usefulness of the MCLE. The findings here have more relevance to female students than male students.

Similar testing needs to be done with both the preferred and the experienced forms of the MCLE, and all analyses should be subjected to cross-validation with independent samples containing similar numbers of female and male students before meaningful conclusions can be drawn regarding the usefulness or otherwise of the MCLE. However, the initial results obtained with the MCLE provide optimism that with this testing and maybe further refinement, a useful instrument for measuring constructivist

learning environments will develop.

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