Factor Structure of Perceived Individualization of Instruction: Argument for Multiple Perspective

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One goal of this study was to investigate the factor structure underlying the individualization of instruction as perceived by (a) content area experts, and (b) teachers who received training in small class teaching. Another goal was to provide educational researchers with better understanding and flexibility in confirmatory-type validations of hypothesized behavioral constructs. The curriculum specialists hypothesized the following four factors for the instrument they developed with the purpose of assessing the effect of teacher training on teaching strategies for individualized instruction: (a) improving instruction, (b) motivation and management, (c) evaluation, and (d) parent involvement. The results from the maximum likelihood confirmatory factor analysis suggested that the hypothesized factor structure did not fit with the data. However, the results from the Kaiser's Factor Matching method indicated a match between three (out of four) factors that emerged from an exploratory factor analysis and three of the hypothesized factors: improving instruction, evaluation, and parent involvement. A general implication is that combining the two confirmatory methods provides a valuable statistical and substantive information that can help researchers in developing and using instruments in education and other behavioral fields.

After hundreds of studies on the effects of class size have been published, there is still an ongoing debate in the literature, as well as at educational and public-policy forums, about the effects and effectiveness of small classes. The titles of most articles on class size issues speak for themselves: "Do small classes mean better schools? Economists aren't so sure" (Shea, 1998), "Small is best, but not for everyone" (Passmore, 1995), "Big doubts over small classes" (Budge, 1997), "Students achieve more in small classes" (Achilles, 1996), "Small classes, big possibilities" (Achilles, 1997). The findings of the Student Teacher Achievement Ratio (STAR) program in Tennessee favored the 1:15 teacher/students ratio. Two follow-up studies, Lasting Benefits Study and Project Challenge supported the results of the STAR program (see Achilles, 1997). Regarding experimental-control group comparisons, previous research reported effect sizes that range from .3 to .7, with

higher achievement of the small class (experimental) groups (see, e.g., Achilles, 1996, 1997). However, Achilles (1997) also indicated the need for multiple measurements in the evaluation of research on class sizes. Of particular importance, we think, is to investigate the role of teacher-related factors (e.g., motivation, experience, teaching quality, training) and the relationship between such factors and student achievement. For example, Williams (1998) reported findings of the National Foundation for Educational Research in England about the relationship between class size and teachers' experiences of teaching a smaller number of pupils.

The results indicated that teachers expended comparable amounts of efforts in large and small classrooms, but teachers in the smaller classrooms were "much more likely to feel that each child was given the chance to realize his or her potential" (Williams, 1998, p. 25). Fernandez, Mateo, and Muniz (1998), after analyzing major historical positions regarding the effect of class size on student performance found a very weak linear relationship between class size and teaching quality. They pointed out a consensus in the empirical literature that "a reduction in class size is not the panacea for all the problems currently besetting educational systems" (p. 601). Rather than refuting the previous models, Fernandez et al. (1998) suggested that the relationship between class size and teaching quality is more complex than previously suggested and that they "give way to a somewhat more complex model in which all of the former can coexist" (p. 601). Possible sources of the complexity and somewhat controversial results regarding the relationship between class size and teaching quality are (a) the quality of teacher training (or no training at all) in small class teaching, and (b) discrepancies in the way curriculum experts and teachers perceive the individualization of instruction.

Purpose: Recognizing the importance and complexity of relationships between teacher-related factors and student-related outcomes in class size variations, the authors of this study investigated the factor structure underlying the individualization of instruction as perceived by (a) content area experts, and (b) teachers who received training in small class teaching. One purpose of this study was to validate a set of hypothesized factors (constructs) of teaching strategies which apply to multicultural awareness. Another purpose was to provide educational researchers with better understanding and flexibility in confirmatory-type validations of hypothesized behavioral constructs.

Method

Instrument: The authors of this study were involved in the evaluation of a reduced class size program for a large school district in northeast Ohio. As a part of a reduced class size program, the Public School personnel along with teacher- training professionals developed a set of in-services which were designed to increase awareness of the need for individualized teaching techniques and to use evaluation procedures for the purpose of improving instruction. Curriculum specialists were asked to develop an instrument with the purpose to assess the effect of the training program on teachers' functioning in areas of individualized instruction. They also defined four theoretical constructs which, by their unanimous expert judgments, underlie the structure of the instrument. Table 1 shows the items of the instrument and their hypothesized factor structure of theoretical constructs: Improving instruction (II), Motivation and management (MM), Evaluation (EV), and Parent involvement (PI). The Cronbach's reliability for the items defining these four constructs was .86, .86, .76, and .77, respectively. Taking into account the relatively small number of items per construct, these values were adequate for the purposes of the confirmatory factor analysis used in this study. The Cronbach's reliability for the entire instrument was .92.

Subjects. The instrument was administered to 74 kindergarten and first grade teachers who received the training program and were teaching reduced class size (17 or fewer students). Teachers were asked the question "How much better are you now able to function in the following areas due to the training you have received (NOT to small class size)?" and were required to rate each item on the scale: 1 = same as before, 2 = a little better than before, 3 = better than before, 4 = much better than before.

Procedures. A confirmatory factor analysis was used for the validation of constructs underlying the instrument as hypothesized by the curriculum specialists. This analysis was conducted by using the computer program Amos (Arbuckle, 1997) which performs the confirmatory maximum likelihood method (see, e. g., Gorsuch, 1983, pp. 127-141). An important characteristic of the maximum likelihood method is that it provides a chi-square statistic with the null hypothesis being that all the population covariance has been extracted by the hypothesized factors. Thus, if the chi-square is not significant at the designated probability level, one can accept that the hypothesized factor model is adequate and fit with the data. The goodness-of-fit index (GFI) was also used in this study. This index is roughly analogous to the multiple R^2 in multiple regression in that it shows the overall amount of the covariation among the observed variables that can be accounted for by the hypothesized factor model. The adjusted for population value of this index is denoted by AGFI. A rule of thumb is that when the GFI exceeds .90, it can be used as an indication of a good fit (see, e. g., Stevens, 1996, p. 399).

The chi-square statistic and the GFI index for the maximum likelihood confirmatory analysis provide an omnibus type of evidence for the fit (or misfit) of the hypothesized factor model with the data. These statistics, however, do not provide information about possible partial adequacy of the hypothesized model which might be of great interest in many research scenarios. In order to focus the attention of educational researchers on this problem and to illustrate one approach to its solution, the Kaiser's Factor Matching (Kaiser, 1960; Veldman, 1967; Newman, 1971, Galligan & Newman, 1983) was conducted in this study. An exploratory factor analysis was conducted using the principal axis method with Varimax rotation (see, e.g., Gorsuch, 1983, p. 184). The factors obtained in this analysis was submitted to the Kaiser's Factor Matching in order to determine possible partial matching of one or more of the observed (exploratory) factors structure and the hypothesized factor structure defined in Table 1. The Kaiser's Factor Matching (Kaiser, 1960), along with the Fortran program RELATE for computer processing, is explained in details by Veldman (1967, pp. 236-244). The origins and factor-vector orientations for the compared factor structures (observed and hypothesized) are equated. One of the factor spaces is then rotated to maximize the degrees of overlap between corresponding test vectors in the two structures. The output represents the degree of rotation of the space as a matrix of cosines of the angles between all pairs of factor axes in the two structures. The cosines are interpretable as correlations between the factors in the two structures. As a conventional rule, cosines above .95 indicate a strong degree of similarity, cosines between .75 and .95 indicate high similarity, and cosines below .75 indicate dissimilarity in the structure of the two factor axes (Veldman, 1967).

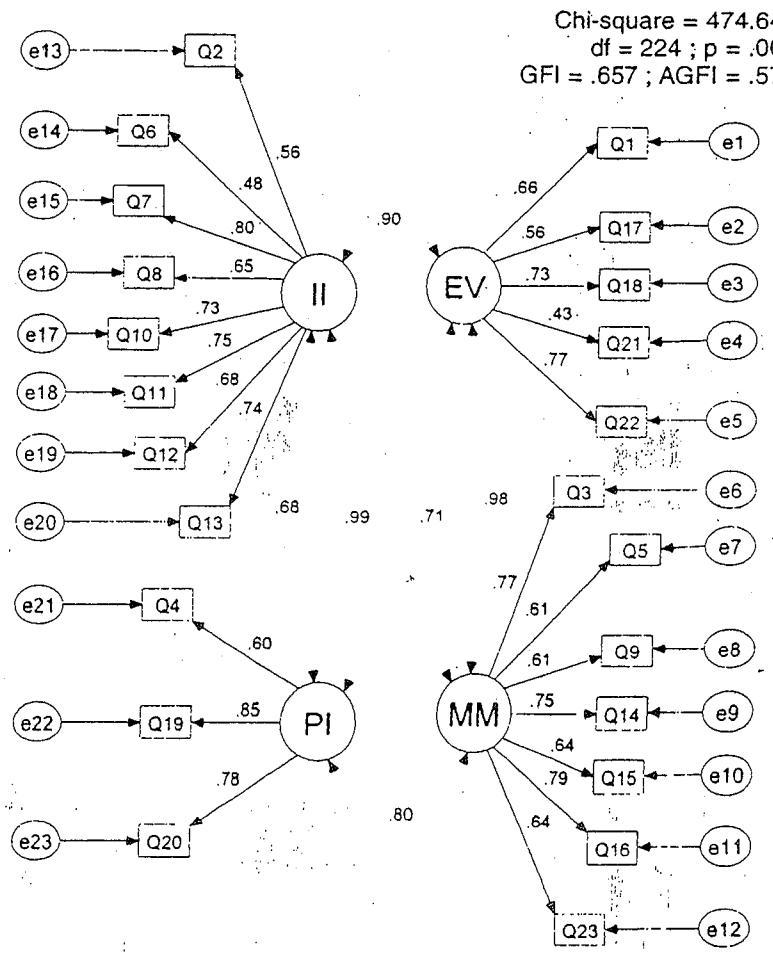
Table 1: **Factor Structure of Items of Individualized Instruction Hypothesized by Curriculum Specialists**

	Hypothesized factors			
Item	II.	MM	EV	PI
Identifying student needs	0	0	1	0
Providing intervention	1	0	0	0
Keeping class focused	0	1	0	0
Giving feedback to parents	0	0	0	1
Providing reinforcement	0	1	0	0
Experiencing less teacher stress	1	0	0	0
Individualizing instruction	1	0	0	0
Using reading strategies	1	0	0	0
Handling discipline problems	0	1	0	0
Providing one-to-one feedback/instruction	1	0	0	0
Interacting with students	1	0	0	0
Providing small group instruction	1	0	0	0
Accomplishing teaching objectives	1	0	0	0
Facilitating interaction and involvement	0	1	0	0
Having better control of class	0	1	0	0
Working with every child	0	1	0	0
Assessing students early in year	0	0	1	0
Having discussions with students	0	0	1	0
Developing student/parent relationships	0	0	0	1
Parents more willing to be involved	0	0	0	1
Determining student DRA level	0	0	1	0
Identifying student strengths/weaknesses	0	0	1	0
Fewer frustrations for students	0	1	0	0

Note. Teachers rated each item in terms how much better they were able to function due to the training program (NOT to small class size) on a 4-point Likert- type scale. The entry of 1 in the hypothesized factor structure indicates that the curriculum specialists associated the item with the factor (II = Improving instruction, MM = Motivation and management, EV = Evaluation, PI = Parent involvement.)

Results

The results from the maximum likelihood confirmatory factor analysis, as given in the Amos computer printout, are represented in Figure 1. The chi-square being significant ($\chi^2(224) = 474.64$, $p = .000$) and the goodness-of-fit index (GFI = .657) being much lower than .90, one can conclude that the hypothesized factor model does not fit with the data. Different four factors emerged from the exploratory factor analysis on the same data (see Table 2). These four factors, explaining 58.48% of the total variance of the items, were then rotated with the Kaiser's Factor Matching



method in order to investigate for partial matching between the "exploratory" factors obtained by the exploratory factor analysis (F_{E1}, F_{E2}, F_{E3}, F_{E4}) and the hypothesized factors (F_{H1} = II, F_{H2} = MM, F_{H3} = EV, F_{H4} = PI) defined by the curriculum specialists (Table 1 and Figure 1).

Table 2: Exploratory Factor Analysis of the Items of Individualize Instruction

Item	Factors F_{E1}	F_{E2}	F_{E3}	F_{E4}
Identifying student strengths/weaknesses (EV)	.702	.300	.190	.168
Using reading strategies (II)	.689	.248	.189	.147
Determining DRA level (EV)	.673	-.012	.086	-.067
Identifying student needs (EV)	.639	.155	.238	.210
Providing intervention (II)	.591	.287	.009	.101
Working with every child (MM)	.589	.493	.272	.128
Fewer frustrations for students (MM)	.544	.334	.078	.212
Assessing students early in year (EV)	.447	.213	.144	.276
Providing reinforcement (MM	.430	.282	.178	.324
Interacting with students (II)	.165	.813	.228	.096
Accomplishing teaching objectives (II)	.189	.736	.137	.356
Facilitating interaction and involvement (MM)	.331	.635	.200	.256
Having discussions with students (EV)	.263	.614	.223	.354
Individualizing instruction (II)	.463	.593	.311	.048
Providing small group instruction (II)	.305	.529	.317	.049
Providing one-to-one feedback (II)	.430	.499	.255	.131
Having better control of class (MM)	.138	.313	.788	.206
Handling discipline problems (MM)	.088	.390	.719	.109
Experiencing less teacher stress (II)	.221	.066	.625	.231
Giving feedback to parents (PI)	.309	.323	.406	.228
Developing student/parent relationships (PI)	.161	.299	.235	.823
Parents more willing to be involved (PI)	.155	.117	.458	.626
Keeping class focused (MM)	.363	.405	.423	.424

Note. The items are given in descending order of the loadings (in bold) for the factor they define. Given in parentheses after each item is the hypothesized factor (II = Improving instruction, MM = Motivation and management, EV = Evaluation, PI = Parent involvement) for this item.

The cosines between factors of the two factor structures (exploratory and hypothesized), as reported by the computer program RELATE (Veldman, 1967) for the Kaiser's Factor Matching, are given in Table 3. The cosines above .75, representing correlations between exploratory and hypothesized factors, were (a) .7900 between F_{E1} and F_{H1}, (b) .7600 between F_{E2} and F_{H3}, and (c) .9027 between F_{E4} and F_{H4}. The examination of Table 3 shows that there was a solid match for the hypothesized factors F_{H1} (Improving instruction) and F_{H4} (Parent involvement), because each of them had a highly correlation with one exploratory factor and low correlations with the rest of exploratory factors. In this sense, there was not clear match for the hypothesized factor F_{H3} (Evaluation), and no match at all for the hypothesized factor F_{H2} (Motivation and management).

Table 3: Kaiser's Factor Matching Test. Cosines Among Factor Axes of Exploratory and Hypothesized Factors of Perceived Individualization of Instruction

Hypothesized factors	Exploratory factors F_{E1}	F_{E2}	F_{E3}	F_{E4}
F_{H1} (II = Improve instruction)	.7900*	.0445	.4881	-.3683
F_{H2} (MM = Motivation and management)	-.4581	.6449	.6022	-.1058
F_{H3} (EV = Evaluation)	.3609	.7600*	-.5047	.1957
F_{H4} (PI = Parent involvement)	.1904	-.0710	.3789	.9027*

* The cosine may be interpreted as a significant correlation between the two factors.

Discussion

As a part of part of a reduced class size program for a large school district in northeast Ohio, the Public School personnel along with teacher-training professionals developed a training program designed to increase awareness of the need for individualized teaching techniques and to use evaluation procedures for the purpose of improving instruction. Curriculum specialists developed an instrument for assessing the effect of the training program on teachers' functioning in key areas of individualized instruction. They hypothesized four factors underlying the structure of the instrument: Improving instruction, Motivation and management, Evaluation, and Parent involvement. Combining two methods of confirmatory factor analysis, the authors of this study investigated the validity of the hypothesized factor structure of perceived individualization of instruction.

The results from the maximum likelihood confirmatory factor analysis suggested that the hypothesized factor structure did not fit with the data. The omnibus nature of this finding does not provide specific information about partial adequacy of the hypothesized model. In order to address this problem, the authors of this study conducted the Kaiser's Factor Matching procedure which matches a given (reference) factor structure to a hypothesized (theoretical) factor structure. In this case, the factor structure produced by an exploratory factor analysis was tested against the factor structure hypothesized by the curriculum specialists. The results indicated a strong match for two hypothesized factors: Improving instruction and Parent involvement. There was no clear match for the factor Evaluation, and no match at all for the factor Motivation and management. An implication for the curriculum specialists is that while they may build upon items related to improving instruction and parent involvement, they have to revise the way they conceptualize (a) evaluation, and (b) motivation and management in the context of individualized instruction.

The results of this study imply the necessity of multiple perspectives in confirmatory validations of behavioral constructs. Relying only on omnibus statistical tests in confirmatory validation may be insufficient, even misleading, in many research scenarios. As illustrated in this study, using the Kaiser's Factor Matching method in addition to the maximum likelihood confirmatory factor analysis, provides information on which individual factors appear to be stable in representing specific theoretical constructs. Thus, the combination of these two methods provides researchers and practitioners with both statistical and substantive information which can help them in developing and using instruments in the context of educational and other behavioral fields.

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