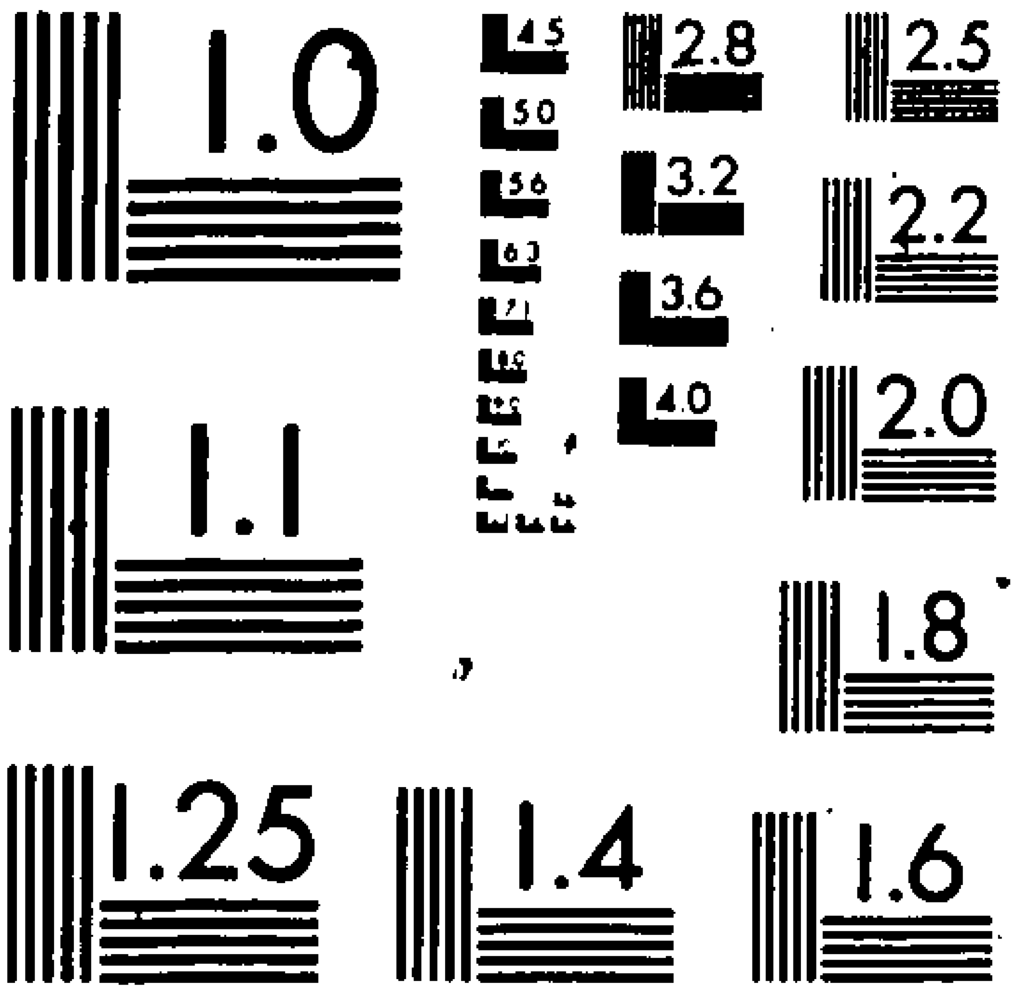

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ABSTRACT

This study evaluates the Unified Sciences and Mathematics for Elementary School (USMES) curriculum developed by the Education Development Center in Massachusetts. Effects of using USMES materials on students' economic understanding, attitudes, and problem-solving ability were explored. The research also examined the simultaneous relationship between achievement and attitudes. In the study, control and experimental classes were selected on the basis of whether the classroom teacher had participated in a summer inservice program on economic problem solving. Teachers in the experimental inservice group were exposed to basic economic concepts and their application to problem solving in the classroom. Students in their classes worked on an economics-oriented USMES unit, "Manufacturing," during one semester. Teachers in the control group received no instruction in economics or problem solving during the evaluation period. Results indicated that intermediate elementary students significantly improved their economic understanding by working on comprehensive, realistic, and economic-oriented problems as found in the USMES curriculum. These students seemed to develop a substantially more positive attitude toward economics. Also, the program seemed appropriate for both cognitive and affective learning. However, an untrained teacher would probably have difficulty adding an economic dimension to student problem solving from simply reading the USMES materials. Therefore, inservice training will improve teachers' economic understanding and will prepare them for introducing USMES material into the classroom. (Author/KC)

Estimating the Effects of Economic Problem Solving in Elementary Schools*

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(September, 1978)

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Introduction

The stated purpose of economic education is to provide students with the economic understanding and problem-solving ability to deal with both personal and societal economic problems [15]. To achieve this purpose, students at all ages may need experience in working on meaningful economic problems [12, 13, 26]. Unfortunately, few opportunities have been provided for elementary students to learn economics using a realistic problem solving approach.[1]

One reason for the failure to implement various approaches for teaching economics may be the inadequate economic understanding of elementary teachers [21, 25]. Although extensive resources have been used to upgrade teachers' stock of economic knowledge through in-service course work [23], more research is needed on the methods, materials, and types of in-service training which are effective in the classroom [6]. Combining in-service economic instruction with training in the use of a realistic problem solving approach may improve economic understanding of elementary teachers and their students.

In estimating the effects of programs on student economic learning, most evaluation studies in economic education have only measured student outcomes in the cognitive domain and have often neglected to measure student learning in the affective domain [20]. Moreover, the possibility of a simultaneous relationship between achievement in economics and attitude towards economics[2] may require the use of simultaneous equations techniques, such as two stage least squares (TSLS), to obtain consistent estimates of model parameters. This statistical procedure has received limited use in economic education studies.[3]

This study investigates the effects of a teacher in-service program that provided instruction in economics and problem solving as it applied to the Unified Sciences and Mathematics for Elementary School (USMES) curriculum [9]. Single and simultaneous equation models are specified and estimated to account for the effects of achievement and attitude on one another in student economic learning. To measure the effects of the in-service training on teachers' economic understanding, a single equation model is also estimated. Finally, summary estimates of the full effects of the in-service program on students are obtained using combined results from student and teacher data analyses.

Design of the Study

This study was conducted in the St. Paul (Minnesota) Public Schools. A non-equivalent control group design was used with control and experimental classes selected on the basis of whether the classroom teacher participated in a summer in-service program on economic problem solving.[4] Treatment for the experimental teachers involved exposure for three hours a day over a four-week period to basic economic concepts and their application to problem solving in the classroom. Experimental treatment for students included working on an economics-oriented USMES unit Manufacturing [10], over an eight-week period in the subsequent fall.[5] Control teachers and students received no instruction in economics or problem solving during the evaluation period.

Information on student age, sex, grade level, and absences was obtained from a questionnaire.[6] Student socioeconomic status (SES) was estimated from census tract estimates of the average value of housing on the block where the student lived.[7] Student understanding of economics was measured by a reduced 29 question form of the Test of Elementary Economic (TEE) [36]. Student attitude towards economics was assessed by a semantic differential instrument. Pre and post-test teacher knowledge of economics was measured with forms A and B, respectively, of the Test of Economic Literacy (TEL) [17]. All test instruments showed suitable reliability and validity.[8]

Experimental teachers were pre-tested on the first day of the in-service workshop and post-tested on the last day of the workshop. Control teachers were pre-tested at the beginning of the workshop and post-tested at the time their students received their pre-tests. Students were post-tested eight weeks later. The teacher sample consisted of 17 teachers, seven control and 10 experimental. For the analysis of student economic understanding, the sample size was 333, 156 control and 177 experimental.[9]

A Simultaneous Economic Learning Model

The model used for analysis of student economic learning is presented in equations 1 and 2 in Figure 1. In structural equation 1, post-test economic understanding (Y_1) is considered to be a function of: post-test attitude towards economics (Y_2), age (X_1), sex (X_2), SES (X_3), pre-test economic understanding (X_4), grade levels (X_6, X_7); absences (X_8), teacher post-test economic understanding (X_9), and group (control or experimental, X_{10}), plus a constant term (X_0) and an error term (U_1). On the other hand, post-test attitude towards economics (Y_2) is expressed in structual equation 2 as a function of post-test economic understanding (Y_1), age (X_1), sex (X_2), SES (X_3), pre-test attitude towards economics (X_5), grade levels (X_6, X_7), absences (X_8), teacher post-test economic understanding (X_9), and group (X_{10}), plus a constant term (X_0) and an error term (U_2). The two structural equations form a model that incorporates a reciprocal, casual link between the two endogenous variables, post-test economic understanding (Y_1) and post-test attitude towards economics (Y_2).[10]

In this simultaneous equation model pre-test attitude towards economics (X_5) is excluded from equation 1, where post-test economic understanding (Y_1) was the dependent variable. The reason for this exclusion is based on the following "chaining" and was not arbitrary. Pre-test attitude (X_5) is directly related to post-test attitude (Y_2), as shown in equation 2 of the model. Post-test attitude towards economics (Y_2), in turn, directly

FIGURE .1

AN ECONOMICS LEARNING MODEL

(structural equations 1 and 2)

(1) $$Y_1 = \beta_{12}Y_2 + \gamma_{10}X_0 + \gamma_{11}X_1 + \gamma_{12}X_2 + \gamma_{13}X_3 + \gamma_{14}X_4 + \gamma_{16}X_6 + \gamma_{17}X_7 + \gamma_{18}X_8 + \gamma_{19}X_9 + \gamma_{110}X_{10} + U_1$$

(2) $$Y_2 = \beta_{21}Y_1 + \gamma_{20}X_0 + \gamma_{21}X_1 + \gamma_{22}X_2 + \gamma_{23}X_3 + \gamma_{25}X_5 + \gamma_{26}X_6 + \gamma_{27}X_7 + \gamma_{28}X_8 + \gamma_{29}X_9 + \gamma_{210}X_{10} + U_2$$

where:

Y_1 = post-test economic understanding

Y_2 = post-test attitudes towards economics

X_0 = 1 (constant term)

X_1 = age

X_2 = sex

X_3 = socioeconomic status

X_4 = pre-test economic understanding

X_5 = pre-test attitude towards economics

X_6 = grade 4

X_7 = grade 5

X_8 = absences

X_9 = teacher post-test economic understanding

X_{10} = group

U_1 and U_2 = error terms.

influences post-test economic understanding (Y_1), as shown by the inclusion of Y_2 as a regressor in equation 1. Only a contemporaneous direct link is assumed to exist between the cognitive and affective domains. In other words, the model specifies that pre-test attitude towards economics (X_5) only has an indirect effect on post-test economic understanding (Y_1) through its direct effect on post-test attitude towards economics (Y_2). In each structural equation (1 or 2), only the direct effects of variables are included. Hence, the exclusion of pre-test attitude towards economics (X_5) from equation 1, but its inclusion in equation 2.[11] In this manner, the model specifications for the structural equations provide an explicit way to describe the complex relationships between variables, rather than just assuming that all effects are direct, with one-way causality, as would be done in a single equation learning model.

A cumulative or total description of these complex relationships can be provided by solving for the reduced form equations for the economic learning model as given in Figure 2. The reduced form and the structural equations are alternative representations of the same model in that both describe the relationship between economic achievement and attitude in the classroom. But the reduced form and the structural equations provide different information and require different estimation procedures. The reduced form equations summarize the entire structural model in terms of the total change expected in each endogenous variable from a change in any one of the exogenous variables. The structural equations, on the other hand, merely provide the direct effect of relevant variables on an endogenous variable.

Problems in Parameter Estimation

If the use of OLS estimation procedures is to be applied to each of the structural equations of the model, then a number of assumptions about the error

FIGURE 2

AN ECONOMICS LEARNING MODEL
(reduced form equations 3 and 4

$$(3)\quad Y_1 = \frac{\beta_{12}\gamma_{20} + \gamma_{10}}{1 - \beta_{12}\beta_{21}} X_0 + \frac{\beta_{12}\gamma_{21} + \gamma_{11}}{1 - \beta_{12}\beta_{21}} X_1 + \frac{\beta_{12}\gamma_{22} + \gamma_{12}}{1 - \beta_{12}\beta_{21}} X_2$$

$$+ \frac{\beta_{12}\gamma_{23} + \gamma_{13}}{1 - \beta_{12}\beta_{21}} X_3 + \frac{\beta_{12}\gamma_{24} + \gamma_{14}}{1 - \beta_{12}\beta_{21}} X_4 + \frac{\beta_{12}\gamma_{25}}{1 - \beta_{12}\beta_{21}} X_5$$

$$+ \frac{\beta_{12}\gamma_{26} + \gamma_{16}}{1 - \beta_{12}\beta_{21}} X_6 + \frac{\beta_{12}\gamma_{27} + \gamma_{17}}{1 - \beta_{12}\beta_{21}} X_7 + \frac{\beta_{12}\gamma_{28} + \gamma_{18}}{1 - \beta_{12}\beta_{21}} X_8$$

$$+ \frac{\beta_{12}\gamma_{29} + \gamma_{19}}{1 - \beta_{12}\beta_{21}} X_9 + \frac{\beta_{12}\gamma_{210} + \gamma_{110}}{1 - \beta_{12}\beta_{21}} X_{10} + \frac{\beta_{12}U_2 + U_1}{1 - \beta_{12}\beta_{21}}$$

$$(4)\quad Y_2 = \frac{\beta_{21}\gamma_{10} + \gamma_{20}}{1 - \beta_{21}\beta_{12}} X_0 + \frac{\beta_{21}\gamma_{11} + \gamma_{21}}{1 - \beta_{21}\beta_{12}} X_1 + \frac{\beta_{21}\gamma_{12} + \gamma_{22}}{1 - \beta_{21}\beta_{12}} X_2$$

$$+ \frac{\beta_{21}\gamma_{13} + \gamma_{23}}{1 - \beta_{21}\beta_{12}} X_3 + \frac{\beta_{21}\gamma_{14}}{1 - \beta_{21}\beta_{12}} X_4 + \frac{\beta_{21}\gamma_{15} + \gamma_{25}}{1 - \beta_{21}\beta_{12}} X_5$$

$$+ \frac{\beta_{21}\gamma_{16} + \gamma_{26}}{1 - \beta_{21}\beta_{12}} X_6 + \frac{\beta_{21}\gamma_{17} + \gamma_{27}}{1 - \beta_{21}\beta_{12}} X_7 + \frac{\beta_{21}\gamma_{18} + \gamma_{28}}{1 - \beta_{21}\beta_{12}} X_8$$

$$+ \frac{\beta_{21}\gamma_{19} + \gamma_{29}}{1 - \beta_{21}\beta_{12}} X_9 + \frac{\beta_{21}\gamma_{110} + \gamma_{220}}{1 - \beta_{21}\beta_{12}} X_{10} + \frac{\beta_{21}U_1 + U_2}{1 - \beta_{21}\beta_{12}}$$

where:

$\frac{B_{12}U_2+U_1}{1-B_{12}B_{21}}$ = error term for equation 3

$\frac{B_{12}U_1+U_2}{1-B_{21}B_{12}}$ = error term for equation 4

X_0 thru X_{10} were defined previously in Figure 1 terms would have to be met [16]. Namely, the conditions (1) through (5) would be assumed about the error terms, where U_i represents the error terms and E( ) represents the expected value operator:

(1) $E(U_i) = 0$ for all i

(2) $E(U_iU_j) = \sigma^2$, where $i = j$

(3) $E(U_iU_j) = 0$, where $i \neq j$

(4) $E(U_tU_{t+s}) = 0$, where s refers to all time periods other than the period indicated by t

(5) $E(U_iX_i) = 0$, where X_i denotes the regressors.

Conditions (1) through (5) state that the residuals have a zero mean, constant and finite variance, zero covariance between or within an equation, no residual correlation across time within or between equations, and that the independence of the error term with respect to the regressors is zero.

The simultaneous equations bias inherent in the structural equations can be shown by examining the relationship between the error term in equation 1 (U_1) and the endogenous explanatory variable Y_2. For no bias to exist, the correlation between the variables would be expected to be zero. It is known, though, from solving for the reduced form equation 4 for Y_2 that U_1 is part of the error term for Y_2. Therefore, the explanatory variable Y_2 in the structural equation I is correlated with the error term U_1 since:

$$E\{U_1[Y_2 - E(Y_2)]\} = U_1 \cdot \frac{\beta_{21}U_1 + U_2}{1 - \beta_{21}\beta_{12}} = \frac{\beta_{21}}{1 - \beta_{21}\beta_{12}} E(U_1^2) \neq 0 .$$

Similarly, the error term for the structural equation 4.3 (U_2) is correlated with the endogenous explanatory variable Y_1 since:

$$E\{U_2[Y_1 - E(Y_1)]\} = U_2 \cdot \frac{\beta_{12}U_2 + U_1}{1 - \beta_{12}\beta_{21}} = \frac{\beta_{12}}{1 - \beta_{12}\beta_{21}} E(U_2^2) \neq 0 .$$

As a consequence of the correlated error terms (violation of conditions 5), OLS estimation of each of the structural equations can be expected to produce inconsistent estimates of a parameter.[12] Also, the estimated variances of the regressor coefficients are dependent on the estimation of the variance of the error terms (U_1 or U_2) causing estimated variances of the coefficients to be biased. All test statistics are suspect and cannot be relied on for the rejection of the null hypotheses concerning regressor effects. To correct this situation, a TSLS estimation procedure can be employed [16].[13]

Post-Test Economic Understanding

Table 1 reports the OLS and TSLS estimates of the structural equation 1. Both estimation procedures showed the equation to be significant ($F = 36.602$). The R^2 of .517 indicated that more than half of the variance in the data is explained by the equation. The direction of the sign and the size of the coefficients were similar for each estimation procedure.

The most striking difference between the two procedures was the significance test of the effect of the endogenous regressor, post-test attitude towards economics (Y_2), on the dependent variable, post-test economic understanding (Y). The OLS estimate indicated that the relationship was significant ($t = 2.445$; $p < .01$). The TSLS estimate showed the effect of attitude on achievement in economics to be insignificant ($t = .745$; $p > .05$). The use of the inconsistent OLS estimate would lead to the rejection of a true null hypothesis, that post-test attitude had no significant effect on post-test economic understanding, after controlling for the influence of other variables. In other words, use of the OLS estimates may have resulted in a type I statistical error.[14]

Also important for the purposes of this study was the effect of experimental treatment (X_{10}) on post-test economic understanding. After controlling for the influence of other variables, 1.88 out of a possible 29 points was the direct contribution of the problem solving program to post-test economic understanding, as estimated by OLS and TSLS. Students in the experimental group showed a significant difference in their economic understanding when compared to control students as a direct consequence, of their experience in economic problem solving.[15]

Previous research had also indicated that a significant positive relationship exists between students' SES, as measured in numerous ways, and economic understanding [5, 7, 24]. The TSLS and OLS estimates for students' SES (X_3) in equation 1 supported these findings. With this student sample, each increase in $100 in the estimated average value of housing on the block where the student lived contributed a small but significant .005 of a point to the prediction of the post-test economics score. In contrast, each point a student achieved on the pre-test in economics (X_4) added .755 of a point to the post-test economics score. This variable (X_4) as expected, was highly significant and served to explain most of the variance in the post-test economics score.

Other student background characteristics showed less influence on post-test economic understanding (Y_1). The OLS and TSLS estimates for equation 1 indicated that the effects of: age (X_1), sex (X_2), grade level (X_6,X_7), and absences (X_9)[16] were all insignificant in predicting student economic understanding. Of most interest, however, was the apparent insignificance of a teacher's post-test economic understanding in influencing their students' learning of the subject. This result may have been due to the stronger influence of other variables in explaining the post-test scores; or the level of teachers' knowledge may not be sufficient to effectively contribute to student economic learning. Whatever the reason, this finding was not unexpected. The direct effect of teacher economic understanding has not been consistently demonstrated in economic education studies at either the secondary or the elementary level [3, 19].

REGRESSION RESULTS FROM ECONOMIC PROBLEM-SOLVING STUDY
(t-statistic in parentheses)

Regressors	OLS Estimate of Structural Equation 1	TSLS Estimate of Structural Equation 1	OLS Estimate of Reduced Form Equation 1
	Dependent Variable: Post-test economic understanding		
Y_1 Post-test attitude towards economics (7 to 35)	.086 (2.445)*	.087 (.745)	N.A.
X_1 Age (105 to 161)	-.027 (-.821)	-.027 (-.821)	-.025 (-.762)
X_2 Sex (0, 1) 1 = male, 0 = female	-.121 (-.344)	-.121 (-.341)	-.091 (-.259)
X_3 SES (87 to 600)	.005 (2.391)*	.005 (2.379)*	.006 (2.475)*
X_4 Pre-test economic understanding (2 to 29)	.755 (15.177)**	.755 (13.288)**	.769 (15.34)**
X_5 Pre-test attitude towards economics (7 to 35)	N.A.	N.A.	.027 (.739)
X_6 Grade 4 (0, 1) 1 = grade 4, 0 = other	-1.580 (-1.779)	-1.579 (-1.757)	-1.654 (-1.847)
X_7 Grade 5 (0, 1) 1 = grade 5, 0 = other	-.799 (-1.179)	-.799 (-1.172)	-.803 (-1.168)
X_8 Absences (0 to 12)	.071 (.867)	.071 (.865)	.065 (.790)
X_9 Teacher post-test economic understanding (18 to 39)	.013 (.385)	.013 (.375)	.018 (.557)
X_{10} Group (0, 1) 0 = control, 1 = experimental	1.885 (3.879)**	1.882 (2.942)**	2.218 (4.700)**
Constant	2.864 (.603)	2.847 (.548)	3.704 (.762)
Adjusted R^2	.517	.517	.509
SEE	3.174	3.174	3.201
Total equation F	36.602**	36.602**	35.462**
N	333	333	333

*Significant at the .05 level.

**Significant at the .01 level.

The OLS estimates of the reduced form equation 3, as did the OLS and TSLS estimates of structural equation 1, indicated that the total effect of SES (X_3), pre-achievement in economic (X_4), and treatment (X_{10}), were all positively and significantly important in prediction of the post-test score in economics. Also, variables found to be insignificant in structural equation 1 were also insignificant in their estimated total effect in reduced form equation 3. In fact, results from both the reduced form and structural equation estimates showed no significant influence of either pre-test attitude (X_5) or post-test attitude (Y_2) towards economics on post-test achievement in economics (Y_1). Much speculation about the importance of attitude in influencing economic achievement is called into question by these results.

Post-Test Attitude towards Economics

The OLS and TSLS estimates of the structural parameters for equation 2 revealed that the endogenous variable, post-test economic understanding (Y_1), significantly influenced post-test attitude towards economics (Y_2). In fact, as shown by the TSLS estimate in Table 2, each point a student obtained on the post-test in economics contributed on average .223 of a point to the prediction of the post-test attitude score. The OLS estimate of this relationship was lower (.205), but the significance of the effect was greater ($p < .01$) than the significance level of the TSLS estimate ($p < .05$). Again, the reason for this difference may be due to the simultaneous equation bias. In this case, the standard errors for each variable, as derived by OLS estimation, would be incorrect, and all test statistics using OLS estimates would be suspect.

The overall equation F for equation 2 was highly significant ($p < .01$) by both the OLS and TSLS estimates. The adjusted R^2 of .232 indicated the equation explained 23 percent of the variance in the data, a good result in relation to much attitude research in education. Besides

TABLE 2

REGRESSION RESULTS FROM ECONOMIC PROBLEM-SOLVING STUDY
(t-statistic in parentheses)

Regressors	Dependent Variable: Post-test attitude towards economics		
	OLS Estimate of Structural Equation 2	TSLS Estimate of Structural Equation 2	OLS Estimate of Reduced Form Equation 4
Y_1 Post-test economic understanding (2 to 25)	.205 (3.275)**	.223 (2.316)*	N.A.
X_1 Age (105 to 161)	.025 (.496)	.025 (.518)	.019 (.398)
X_2 Sex (0, 1) 1 = male, 0 = female	.358 (.684)	.357 (.680)	.335 (.635)
X_3 SES (87 to 600)	.002 (.496)	.002 (.421)	.003 (.804)
X_4 Pre-test economic understanding (2 to 23)	N.A.	N.A.	.172 (2.297)*
X_5 Pre-test attitude toward economics (7 to 35)	.310 (5.684)**	.309 (5.562)**	.314 (5.680)**
X_6 Grade 4 (0, 1) 0 = other, 1 = grade 4	-.535 (-.402)	-.494 (-.368)	-.864 (-.646)
X_7 Grade 5 (0, 1) 0 = other 1 = grade 5	.129 (.127)	.138 (.135)	-.042 (-.408)
X_8 Absences (0 to 12)	-.082 (-.672)	-.081 (-.664)	-.067 (-.539)
X_9 Teacher pre-test economic understanding (18 to 39)	.062 (1.280)	.062 (1.280)	.066 (1.350)
X_{10} Group (0, 1) 0 = control, 1 = experimental	3.406 (4.757)**	3.360 (4.542)**	3.855 (5.472)**
Constant	9.029 (1.256)	8.997 (1.251)	9.824 (1.355)
Adjusted R^2	.232	.232	.220
SEE	4.738	4.739	4.777
Total equation F	11.047**	11.036**	10.338**
N	333	333	333

*Significant at the .05 level.

**Significant at the .01 level.

post-test achievement (Y_1), two other variables were important in explaining the variance. Not surprising was the strong impact of pre-test attitude (X_5) on post-test attitude towards economics. Each point the student received on the pre-test attitude measure provided .309 of a point on average to the determination of the post-test attitude scores, as estimated by TSLS. Also significant was the effect of experimental treatment (X_{10}) on post-test economic understanding. In receiving instruction in economics through the real problem solving unit, Manufacturing, student post-test attitude towards economics became significantly more positive by 3.36 points out of a possible 28 points, as estimated by TSLS in equation 2. Experience in economic problem solving, then, had a substantial input on both the affective and the cognitive learning of students.

The OLS estimates of the reduced form equation 4 showed that the pre-test economic understanding variable (X_4) significantly contributed to the prediction of post-test attitude (Y_2), together with pre-test attitude (X_5), and the group treatment variable (X_{10}). The significance of pre-test economic achievement (X_4) indicated another clear link between achievement and attitude in economics learning. In this case, the link was an indirect one based on the simultaneous equations model: Pre-test economic understanding (X_4) directly influenced post-test economic understanding (Y_1), which in turn directly influenced post-test attitude towards economics (Y_2).

In conclusion, results from estimating the reduced form equation 4 by OLS and the structural equation 2 by TSLS, showed both a significant effect of either pre-test achievement (X_4) or post-test achievement (Y_1) in economics on post-test attitude towards economics (Y_2). In contrast, results from estimating the reduced form equation 3 by OLS and the structural equation 1 by TSLS, revealed no substantial influence of either pre-test attitude (X_5) or post-test attitude (Y_2) towards economics on post-test achievement in economics (Y_1). These findings suggest, then, that achievement in economics probably has a much stronger effect on attitude towards economics than attitude towards economics has on achievement in the subject. Consequently, one direct means of improving students attitude towards economics appears to be the improvement of their economic understanding.

Teacher Post-test Results

To estimate the effects of the summer in-service program on teachers, a single equation model was specified. Teacher post-test scores in economics were considered to be a function of the following variables in equation 5: age (X_1), pre-test economic understanding (X_2), pre-test interest in economics (X_3), the number of graduate credits received (X_4), and whether the teacher participated in the in-service program (control or experimental, X_5). These variables were selected since they would control for such important factors as maturity, previous knowledge of and interest in economics, and the educational background of the teachers [34, pp. 54-62].

The results in Table 3 showed that pre-test economics score (X_2) was most important in determining the post-test score in economics. In addition, the experimental teachers gained a significant 7.03 out of a possible 46 points, on average, in their economic understanding as a direct result of attending the summer in-service program, after controlling for the effects of other variables. Research in economic education has indicated that in-service training can contribute to the improvement of the economic understanding of teachers [3]. Results from equation 5 lend support to the growing evidence that teachers, including elementary teachers, are able to learn a significant amount of economics even when that instruction is combined with pedagogy. [6, 7].

TABLE 3

REGRESSION RESULTS FOR ECONOMIC PROBLEM-SOLVING STUDY
(t-statistics in parentheses)

Regressors	Dependent Variable: Teacher post-test understanding of economics OLS Estimate of Equation 5
X_1 Age (28 to 53)	-.243 (1.699)
X_2 Teacher pre-test understanding of economics	.659 (3.295)**
X_3 Teacher pre-test interest in economics (1 to 5) 1 = low, 5 = high	1.622 (1.009)
X_4 Number of graduate credits (2 to 60)	.122 (1.906)
X_5 Group (0, 1) 1 = experimental, 0 = control	7.032* (2.314)
Constant	7.306 (.701)
Adjusted R^2	.620
SEE	4.260
Total equation	3.585
N	17

*Significant at the .05 level.

**Significant at the .01 level.

Combining Results: The Total In-Service Impact

Results from post-test student and teacher data analyses can be combined using a procedure suggested by Thornton and Vredeveld [32]. While this procedure does not permit hypothesis testing, it does provide a means of deriving a summary estimate of the full effect of the in-service program. Also the estimates from the simultaneous equations model can be used to calculate a summary measure of learning in both the cognitive and affective domains.

To illustrate this approach, the results from estimating the reduced form equation 3 of the simultaneous equation model show that experimental students differed from control students by 2.218 points in post-test economic understanding.[17] This 2.218 point difference understates the full impact of the in-service program since their is an additional impact on student from the summer in-service program on teacher economic understanding. The reduced form estimate for the total effect of teacher post-test economic understanding (X_9) on student post-test economic understanding in equation 3 was .018. Also, it is known from estimating equation 5 that experimental teachers' knowledge of economics differed from control teachers by 7.032 points on average as a result of participating in the in-service program. Using all three estimates, the in-service program had the total effect of increasing experimental students average test score by 2.35 points (2.218 + .018 x 7.032), or by about 8%.

Similar procedures can be employed to derive an estimate of the full impact of the in-service program on student attitudes towards economics. From the reduced form equation 4, the total effect of the experimental treatment on student attitudes towards economics was estimated to be 3.855 points. The contribution of teacher post-test knowledge of economics on student post-test attitudes towards economics was estimated in equation 4 to be .066. The experimental teachers differed from control teachers by 7.032 points on average in their economic understanding, as shown by Table 5. Consequently, the in-service program had the combined effect of raising experimental students' average attitude towards economics score by 4.319 points (3.855 + .066 x 7.032), or a 15% increase.

Implications

The above findings suggest a number of implications for research, classroom instruction, and in-service training in economic education. Most research in pre-college economic education has measured only achievement outcomes and has failed to assess attitude outcomes. In fact, there may exist a simultaneous relationship between achievement and attitude outcomes in economic learning. Using OLS to estimate a simultaneous relationship between economic achievement and attitude may produce inconsistent estimates of model parameters. Use of TSLS permits consistent estimates to be obtained. For example, when the TSLS procedure was used to estimate the parameters of the economic problem solving model, it appeared that achievement in economics had a significant direct influence on attitude towards economics, but not vice-versa. The use of OLS estimates of this relationship would result in a type I statistical error.

One major purpose of economic education is to provide students with the economic knowledge to handle both personal and societal economic decisions. Intermediate elementary students appear to significantly improve their economic understanding by working on comprehensive, realistic, and economic-oriented problems, as found in the USMES curriculum. In the process, students seem to develop a substantially more positive attitude towards economics. This program appears to be well suited to the level of cognitive development of students and contributes to their affective as well as their cognitive learning.

The economic understanding of most elementary teachers is limited. Also, since USMES materials contain no specific economic content, an untrained teacher would probably have difficulty adding an economic dimension to student problem-solving work from simply reading the materials. Instruction is basic economic concepts and problem solving methods may be necessary for teachers to help them integrate economics into the interdisciplinary problem-solving approach found in USMES. This type of in-service training appears to improve teachers' economic understanding and to prepare teachers for introducing economic problem solving in the classroom.

In short, the findings indicate that teachers and students gain substantial benefits from the in-service program in practical economic problem solving. Simultaneous equation techniques can improve estimates of program effects on economic achievement and attitude.

Footnotes

[1] For a distinction between "real" and "contrived" problem solving see [9, pp. 5-15]. For a discussion of the use of problem solving models for instruction in economics and the social studies, see [34, pp. 3-19].

[2] In economic education research, attitude has been considered in some studies to a function of achievement [13, 18, 29]. In fact, Gery [13] estimated a learning model and concluded that "attitudes and feelings may be just as significant as aptitude and achievement in explaining economic understanding." [p. 158]. On the other hand, studies have also indicated that economic understanding may significantly influence student attitude towards economics [33, 35]. No studies appear, to have examined the joint relationship between economic achievement and attitude towards economics. Learning theory also suggests that a reciprocal relationship may exist between the cognitive and affective domains [26, p. 24; 27, p. 76].

[3] The most notable exception is a study by Becker and Salemi [2]. For a discussion of the application of various statistical procedures to non-recursive models in educational research, see Anderson [1]. Soper [30, p.239] recommends multiple linear regression analysis for most economic education studies.

4. Although classes were not randomly assigned to treatment, there was "no reason to suspect differential recruitment" related to treatment. Following this distinction by Campbell and Stanley [4, pp. 219-220], the study design can be considered as a non-equivalent control group design.

[5] The problem in the Manufacturing unit was "to produce in quantity an item that is needed." [10, p v]. Among the items made were stuffed animals, clay pots and ornaments, bookmarks, jewelry, 1978 calendars, pillows, school emblem folders, candles, and pencil or ticket holders.

[6] Age was expressed in months since this variable would serve to explain more variance in the data than age in years. A grade level variable was included to reflect possible differences in curricula experienced by students.

[7] As has been noted by others [31], the income-housing relationship may not be perfect and corrections may be necessary. However, for this study, the correlation between the average value of housing and family income in each of the school enrollment areas was .94.

[8] (1) The selection of items to eliminate from the TEE was based on their extreme difficulty level in a previous separate sample study. The increase in reliability (.53 to .65; KR-20) did not come at the expense of content validity since all areas of the test matrix were still covered. (2) Scales in the semantic differential included: valuable-worthless; serious-funny; important-unimportant; useful-useless; careful-haphazard; logical-illogical; important for the future-unimportant for the future. The value of this approach has been established [8, 35]. The pre- and post-test reliability of the attitude measure was .82 and .88, respectively. (3) The TEL was used with elementary teachers since the test measured understanding of basic economic concepts, as taught in the program. The pre- and post-test reliability was .79 and .81, respectively.

[9] Extensive hypothesis testing was conducted to provide a basis for aggregation of classes into control and experimental groups. Also, pre-test differences in economic understanding and attitudes towards economics were examined. Although the pre-test group differences were slight, the pre-test scores continued to be as regressors in the post-test analysis [34, pp. 110-137].

[10] For this study, pre-test economic achievement and attitude are being considered exogenous variables. Using a more technical distinction, these variables are lagged endogenous variables. It is customary to consider exogenous and lagged endogenous variables as pre-determined variables. There are some problems with this distinction, as has been noted by Maddala [22, p. 238] among others.

[11] Following a similar reasoning process, pre-test economic understanding (X_4) was excluded from structural equation 2.

[12] The reduced form equation expresses each endogenous variable as a function of only exogenous variables. In the reduced form equation, condition (5) is not violated; OLS estimation procedures can be used to obtain consistent <u>total</u>, but not <u>direct</u>, estimates, assuming that conditions (1) to (4) are met.

[13] Indirect least squares can also be used to derive the unique, consistent parameter estimates. These estimates will be identical to TSLS estimates when the equations are exactly identified, as is the case in this model [16].

[14] One of the reasons for the different test results is the nature of the standard errors for the OLS and TSLS estimates. In general, the standard errors obtained from the TSLS estimates are greater than those for the OLS estimates. This does not mean, though, that the OLS method is better. The standard errors from the OLS method cannot be the correct ones, as those estimates fail to control for the simultaneous relationship that may exist. The TSLS estimates, then, are at least assymptotically the correct estimates within the equational system considered. [22, p. 241].

[15] Similar results have been found by Ellis and Glenn [11] using the Manufacturing unit with upper middle class students.

[16] The absence variable (X_8) was highly positively skewed. However, attempts to reduce the skewness through variable transformations failed to change the results.

[17] The reduced form estimates are used here instead of the TSLS estimates for one reason. The reduced form estimates measure the total effect of a variable on the dependent variable, and not just the direct effects, as is the case with TSLS estimates.

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