The relationships between engineering teachers' collective efficacy, student learning efficacy and learning outcomes in Taiwan's industrial vocational high schools

David W.S. Tai†, Yang-Chih Hu‡, Ray Wang† & Judy F.M. Chen*

Hungkuang University, Taichung, Taiwan†
National Sha-Lu Industrial Vocational High School, Taichung, Taiwan‡
Overseas Chinese University, Taichung, Taiwan*

ABSTRACT: The purpose of this study was to explore the collective effectiveness of teachers' influence on student learning outcomes, the results of which will provide a teaching reference. The survey research method was applied to this research (valid retrieved questionnaires, with 181 teachers and 543 students). Structural Equation Modeling (SEM) was applied to data analysis and mode verification of the questionnaires analysed. The conclusions were that teachers' collective efficacy has a positive influence on learning efficacy, and that teachers' collective efficacy has a positive influence on student learning outcomes.

INTRODUCTION

Hoy, Tarter and Hoy; Woolfolk, Rosoff and Hoy; believed there was a direct and positive relationship between students' learning outcomes, teachers' efficacy and students' learning efficacy [1][2]. A connection exists between the three factors of learning efficacy [3], teacher efficacy [4] and collective teacher efficacy [5]. The majority of study results state that compared to students' self-concepts and previous grades, learning efficacy was more predictable and directly connected to students' learning outcomes. In addition, enhanced learning efficacy also enhanced students' patience and improved their performance. Therefore, learning efficacy was an essential variable for students' learning outcomes.

Bandura introduced the concept of collective efficacy as an extension of self-efficacy [6]. Previous studies had confined teachers' effectiveness to teacher self-efficacy [7-9]. Baker pointed to collective efficacy as being rooted in self-efficacy [9]. As previous studies held less discussion on the influence of students' learning efficacy and collective efficacy, the research purpose of this study was to explore the influence of teachers' collective efficacy on student learning outcomes, and the results will provide a teaching reference.

LITERATURE REVIEW

Collective Efficacy

Bandura indicated that collective efficacy involves the individual's perceptions regarding the group's performance capabilities [10]. Goddard, Hoy and Hoy; offered the concept of collective teacher efficacy and applied it to teacher efficacy study [5]. In Goddard's study, the content of teachers' effectiveness not only involves teachers' efficacy but also collective teacher efficacy. Traditional teacher effectiveness involves just teacher efficacy.

Tschannen-Moran, Hoy and Hoy; suggested a model that added two key elements (group competence and task analysis) to the development of collective efficacy [4]. Their argument for the need of the two additional elements was based upon the fact that teacher efficacy is context-specific. Therefore, an appropriate model to measure collective teacher efficacy and personal teacher efficacy should include not only Bandura's four sources but also an analysis of the teaching task [5]; its context, and an assessment of personal teaching competence [4][5].

Goddard, Hoy and Hoy; created an instrument to include positively and negatively worded items to measure group competence (GC+, GC-) and positively and negatively worded items to measure task analysis (TA+, TA-) [5]. Purkey and Smith; Murphy et al; Hoy and Miskel; considered that teacher collective efficacy can motivate students' learning outcomes [11-13].

Learning Efficacy

According to Multon et al; Schunk; Hackeet and Betz'; research results, learning efficacy is more predicable than self-concept and previous grades [14-16]. Learning efficacy was directly connected to students' learning outcomes as well, which is a key variable of students' learning outcomes. Schunk and Swartz considered that enhanced student learning efficacy could stimulate interest in learning and cultivate patience in difficulties with learning [17]. Once learning efficacy has been improved, students' internal learning motivation would be inspired as well; original passive studies turn into positive study. The changes circulate learning efficacy development [18].

Research Hypothesis

Teacher collective efficacy affects students' learning outcomes on specific tasks [19-21]. Gibson and Dembo indicated that teacher collective efficacy affects students' learning outcomes more strongly than does students' race, social background and economic level [22]. Moreover, teacher efficacy takes differing forms; teacher collective efficacy not only has a huge influence on educational achievement but it is also malleable.

In the study, the major research hypotheses are as following:

H1: Teacher collective efficacy has a positive influence on learning efficacy.
H2: Teacher collective efficacy has a positive influence on students' learning outcomes.
H3: Learning efficacy has a positive influence on students' learning outcomes.

METHOD

Study Structure

The study was set up to investigate the route that teacher collective efficacy influence takes on learning efficacy and students' learning outcomes. Study structure is shown in Figure 1.

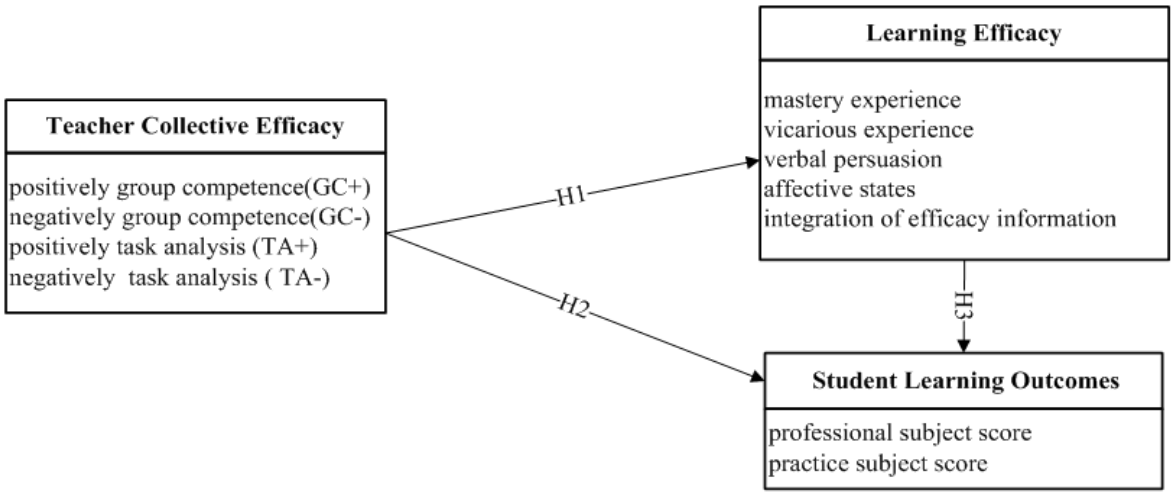

Figure 1: Research structure.

Study Sample

The study participants were selected from a representative sample of vocational high school students in Taiwan. Each participant was asked to complete a survey with items, measuring their beliefs, related to the Professional Teacher Collective Efficacy Scale. The questionnaires were administered by the researchers. Follow-up surveys were administered to all participants. A total of 181 surveys were distributed to an industrial vocational high school in Taiwan, and the student sampling of three was drawn randomly from the teachers' class. Sampling description is shown in Table 1.

Study Instrument

Initial Reliabilities

Teacher Collective Efficacy Questionnaire (TCEQ): Factors such as positively group competence (GC+), negatively group competence (GC-), positively task analysis (TA+) and negatively task analysis (TA-), were used. The scale of measurement was a 7-point Likert-type response scale and Cronbach's alpha coefficient for the scale was 0.90.

Student Learning Efficacy Questionnaire (SLEQ): In this study, 16 items were identified that were related conceptually to students' efficacy on mastery experience, vicarious experience, verbal persuasion, affective states and integration of efficacy information. The scale of measurement was a 7-point Likert-type response scale and Cronbach's alpha coefficient for the scale was 0.89.

Confirmatory Factor Analysis (CFA)

The TCEQ by CFA was applied to test the remaining 16-item four-factor model and the SLEQ was also applied to test the remaining 16-item five-factor model. The structures of item loadings were consistent with the intended theoretical constructs by CFA. Their Composite Reliability (CR) and Variance Extracted (VE) are shown in Table 2.

Table 1: The engineering teachers' background characteristics.

Background Characteristic	Items	Numbers	Percentage (%)
Sex	Male	113	62.43
	Female	68	37.57
Education	Bachelor	55	30.39
	Master	121	66.85
	Doctor	5	2.76
Experience of Teaching	1-5 years	30	16.57
	6-10 years	28	15.47
	11-15 years	39	21.55
	16-20 years	73	40.33
	Above 20 years	11	6.08
Certification of Technician	Class A	8	4.41
	Class B	94	51.93
	Class C	43	23.76
	None	36	19.89

N=181

Table 2: The CR and AVE of CFA on TCEQ and SLEQ.

Questionnaire	Dimension	CR	AVE
TCEQ	positively task analysis (TA+)	0.880	0.650
	negatively task analysis (TA-)	0.841	0.639
	positively group competence(GC+)	0.904	0.525
	negatively group competence(GC-)	0.846	0.579
SLEQ	mastery experience	0.790	0.560
	vicarious experience	0.790	0.562
	verbal persuasion	0.831	0.554
	affective states	0.735	0.486
	integration of efficacy information	0.769	0.529

Data Analysis

This research through Structural Equation Modelling (SEM) undertook theoretical model and goodness-of-fit analysis. First, the focus was on the Measurement Model and a validity test was undertaken. Second, the Structure Model, which was constructed by research hypotheses, used path analysis to assess the relative importance of various direct and indirect paths to the dependent variable. This study utilised the statistical software, LISREL 8.70 and SPSS 12.0.

RESULTS

For this research, through SEM, data analysis and mode verification were undertaken using the analysed questionnaires. The study used Maximum Likelihood Estimation (MLE) to obtain the optimal values for the parameters in the density function.

Also, SEM was used to analyse the study model, and to recognise latent construct from observed variables measurement and to establish the loading on complex-measure items [23].

Structural Equation Modelling Analysis

SEM includes: 1) model fitness analysis, and 2) explanation ability of overall model. In following the suggestions of Bagozzi and Yi; Jöreskog and Sörbom; and Bentler [24-27], eight indices were picked in this study to evaluate the

fitness of the overall model: χ^2 test, compared value between χ^2 and parsimonious fit; GFI (goodness-of-fit index); AGFI (adjusted goodness-of-fit index); RMSEA (root mean square error of approximation); NFI (normed fit index); NNFI (non-normed fit index) and CFI (comparative fit index), as shown in Table 3.

Table 3: Summary of structural model fit analysis.

Fit Indices	Recommended Value	Structural Model	Test Result
χ^2	$p>0.05$	47.67(p=0.135, >0.05)	Yes
χ^2/df	＜3	1.254	Yes
GFI	＞0.8	0.954	Yes
AGFI	＞0.8	0.920	Yes
RMSA	＜0.1	0.038	Yes
NFI	＞0.9	0.975	Yes
NNFI	＞0.9	0.990	Yes
CFI	＞0.9	0.993	Yes

As shown in Table 3, after the Chi-square test (p=0.135,>0.05), and after the measured goodness-of-fit between study model and observed data, best fitness was the result. Bagozzi and Yi considered that a Chi-square test is interrelated with sample size [24]. They suggested that measuring goodness-of-fit should compare the value of Chi-square test and parsimonious fit measure. The value is the less the better, with standard value being less than three [23]. However, if the value is between 3.0-5.0, it is also an acceptable goodness-of-fit [23][29]. Compared to value of χ^2 and parsimonious fit in this study, the value is 1.254. The goodness-of-fit model in this study is acceptable.

Path Analysis

Path coefficients of structured equation modelling of teacher' effectiveness in vocational high school are as follows:

- Teacher collective efficacy → learning efficacy (γ_{11}＝0.52***, t=6.25);
- Teacher collective efficacy → students' learning outcomes (γ_{21}＝0.17**, t=2.03);
- Learning efficacy → students' learning outcomes (β_{21}＝0.82***, t=7.63).

The study model shown in Figure 2, values of the exogenous latent variable and variance explanation ability of overall model, were respectively 0.244 (learning efficacy) and 0.841 (students' learning outcomes). In order to study the teacher effectiveness influence on students' learning outcomes, after analyses and tests, Figure 2 is recognised as a suitable study model.

CONCLUSIONS

Statistical data collected in the questionnaire used in the survey were evaluated through statistical software LISREL 8.7 and the study model was verified. The major findings were as follows:

1. Teacher collective efficacy has a positive influence on learning efficacy.

Path coefficient of the structured equation modelling of teacher collective efficacy influence on learning efficacy is 0.52 (p<0.001).

Schaubroeck, Lam, and Xie; Zellars, Perrewé and Hochwarter; indicate that teacher collective efficacy interacts effectively with students' learning in performing a specific task [20][21].

2. Teacher collective efficacy has a positive influence on students' learning outcomes.

Path coefficient of the structured equation modelling of teacher collective efficacy influence on students' learning outcomes is 0.24 (p<0.001).

Bandura defined collective efficacy as *a group's shared belief in its conjoint capabilities to organize and execute the courses of action required to produce given levels of attainments* [6].

Goddard, Hoy and Hoy claim teacher collective efficacy is different among distinguished schools [31]. Gibson and Dembo state teacher collective efficacy has a greater impact on students' achievement than have race, social background and economic factors [22].

3. Students' learning efficacy has a positive influence on students' learning outcomes.

Path coefficient of the structured equation modelling of learning efficacy influence on students' learning outcomes is 0.84 (p<0.001).

The research results were the same as the findings in this study; according to Multon, et al; Schunk; Hackeet and Betz'; research results [14-16], learning efficacy is more predicable than self-concept and students' previous grades. Learning efficacy is directly connected to students' learning outcomes, as well, which is a key variable of students' learning outcomes. Learning efficacy has 2%-16% incidence of learning outcomes [3].

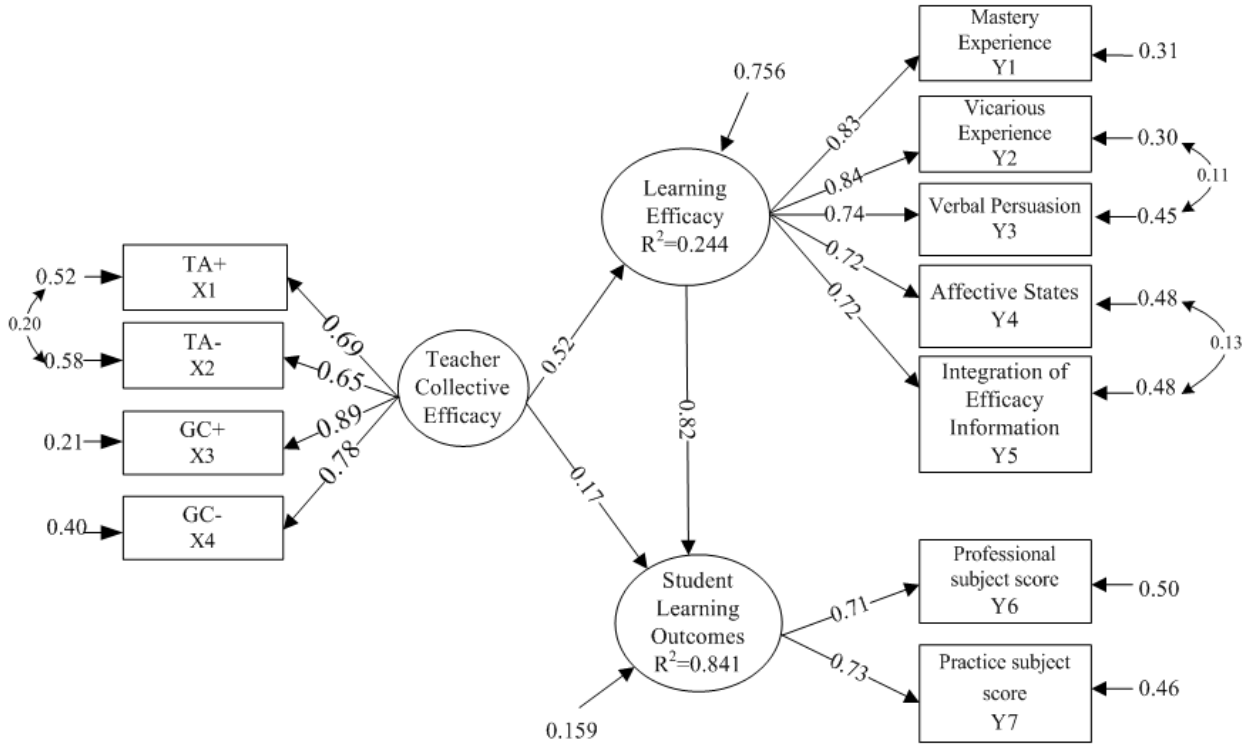

Figure 2: Hypotheses testing results and structural model.

IMPLICATIONS

1. The educational administration should develop an appropriate evaluation model.

The researchers believe teacher efficacy can influence learning outcomes positively [32]. If an educational organisation was to set up an efficient teaching model as a teaching reference, then students' achievements would be improved [33].

2. Teachers' educational courses should be revised in order to enhance teacher efficacy.

According to the study results, teacher efficacy has a great impact on learning achievement. Additionally, self-efficacy also affects teacher efficacy. In order to enhance teachers' effectiveness, during their educational courses, it is important to foster teacher efficacy.

3. Establish school organisational culture and develop teacher collective efficacy.

In vocational education these days, emphasis is placed on team teaching. Schools should develop their own culture and beliefs, so as to achieve cohesion between teachers, staff and students. It is the belief of the researchers of this study that collective working within schools will help the institutions to develop actively and positively.

REFERENCES

1. Hoy, W.K., Tarter, C.J. and Hoy, A.W., *Academic Optimism of Schools: A Second-Order Confirmatory Factor Analysis*. In: Hoy, W.K. and Miskel, C. (Eds), Contemporary Issues in Educational Policy and School Outcomes. Greenwich, CN: Infoage (2006).
2. Woolfolk, A.E., Rosoff, B. and Hoy, W.K., Teachers' sense of efficacy and their beliefs about managing students. *Teaching and Teacher Educ.*, 6, **2**,137-148(1990).
3. Pajares, F., Self-efficacy beliefs in academic settings. *Review of Educ. Research*, 66, 543-578(1996).

4. Tschannen-Moran, M., Hoy, A.W. and Hoy, W.K., Teacher efficacy: Its meaning and measure. *Review of Educ. Research*, 68, **2**, 202-248 (1998).
5. Goddard, R.D., Hoy, W.K. and Hoy, A.W., Collective teacher efficacy: Its meaning, measure, and impact on student achievement. *American Educ. Research J.*, 37, **2**, 479-507 (2000).
6. Bandura, A., *Self-efficacy*: *The exercise of control*. New York: W. H.Freeman (1997).
7. Armor, D., Conroy-Oseguera, P., Cox, M., King, N., McDonnel, L., Pascal, A., Pauly, E. and Zellman, G., Analysis of the school preferred reading programs in selected Los Angeles minority schools (Rep. No. R-2007-LAUSD). Santa Monica, CA: RAND (1976).
8. Newman, F.M., Rutter, R.A. and Smith, M.S., Organizational factors that affect school sense of efficacy, community and expectations. *Sociology of Educ.*, 62, **4**, 221-238(1989).
9. Baker, D.F., The development of collective efficacy in small task groups. *Small Group Research*, 32, **4**, 451-474 (2001).
10. Bandura, A., Self-efficacy: Toward a unifying theory of behavior change. *Psychological Review*, 84, **2**, 191-215 (1997).
11. Purkey, S.C. and Smith, M.S., Effective schools: A review. *The Elementary School J.*, 83, **4**, 427-452 (1983).
12. Murphy, J., Well, P., Hallinger, P. and Mitman, A., School effectiveness: A conceptual framework. *Educational Forum*, 49, **3**, 121-129 (1985).
13. Hoy, W.K. and Miskel, C.G., *Educational Administration: Theory, Research and Practice*. New York: Random House, (1982).
14. Multon, K.D., Brown, S.D. and Lent, R.W., Relation of self-efficacy beliefs to academic outcomes: A meta-analytic investigation. *J. of Counseling Psychology*, 38, 30-38 (1991).
15. Schunk, D.H., Self-efficacy and achievement behaviors. *Educational Psychology Review*, 1, 173-208 (1989).
16. Hackett, G. and Betz, N.E., Mathematics performance, mathematics self-efficacy, and the prediction of math-related college majors. *J. for Research in Mathematics Educ.*, 20, 261-273 (1989).
17. Schunk, D.H. and Swartz, C.W., Goals and progress feedback: Effects on self-efficacy and writing achievement. *Contemporary Educational Psychology*, 18, 337-354 (1993).
18. Moores, T.T. and Chang, J.C-J., Ethical Decision Making in software piracy: initial development and test of a Four-Component Model. *MIS Quarterly*, 30 , **1**, 167-180 (2006).
19. Wang, M.C., Haertel, G.D. and Walberg, H.J., Toward a knowledge base for school learning. *Review of Educational Research*, 63, **3**, 249-294 (1993).
20. Schaubroeck, J., Lam, S.S.K. and Xie, J.L., Collective efficacy versus self-efficacy in coping responses to stressors and control: A cross- cultural study. *J. of Applied Psychology*, 85, **4**, 512-525 (2000).
21. Zellars, K., Perrewé, P. and Hochwarter, W., Mitigating burnout among high-NA employees in the healthcare industry. What can organizations do? Paper presented at the annual meeting of the Academy of Management, Boston (1997).
22. Gibson, S. and Dembo, M.H., Teacher efficacy: A construct validation. *J. of Educational Psychology*, 76, **4**, 569-582 (1984).
23. Chin, W.W. and Todd, P., On the use, usefulness, and ease of use of Structural Equation Modeling in MIS Research: A note of caution. *MIS Quarterly*, 19, **2**, 237-246 (1995).
24. Bagozzi, R.P. and Yi,Y., On the evaluation of Structural Equation Models. *Academy of Marketing Science*, 16, **1**, 76-94 (1988).
25. Jöreskog, K.G. and Sörbom, D., *LISREL: A Guide to the Program and Applications*. (3rd Edn), Chicago: Scientific Software International, Inc. (1992).
26. Bentler, P.M., Comparative fit indexes in structural models. *Psychological Bulletin*, 107, **2**, 238-246 (1990).
27. Bentler, P.M., On the fit of models to covariances and methodology to the Bulletin. *Psychological Bulletin*, 112, 400-404 (1992).
28. Fornell, C. and Larcker, D.F., Evaluating Structural Equation Models with unobservable and measurement errors. *J. of Marketing Research*, 18, 39-50 (1981).
29. Hair, J.F. Jr., Anderson, R.E., Tatham, R.L. and Black, W.C., *Multivariate Data Analysis*. (4th Edn), Englewood Cliffs, New Jersey: Prentice-Hall Inc. (1998).
30. Tschannen-Moran, M. and Barr, M., Fostering student learning: The relationship of collective efficacy and student achievement. *Leadership and Policy in Schools*, 3, **3**, 189-209 (2004).
31. Goddard, R.D., Hoy, W.K. and Hoy, A.W., Collective efficacy beliefs:Theoretical developments, empirical evidence, and future directions. *Educational Research* , 33, **3**, 3-13 (2004).
32. Brophy, J. and Good, T., *Teacher Behavior and Student Achievement*. In: Wittrock, M.C. (Ed), Handbook of research on teaching . (3rd Edn), New York: Macmillan (1986).
33. West, S.S., *Student Perceptions of Teaching Effectiveness*. Texas: Texas A&M University (1990).