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The Relationship between Physical Education Teachers' Perceptions of Principals' Transformational Leadership and Creative Teaching Behavior at Junior and Senior High Schools: A Cross-Level Moderating Effect on Innovative School Climates

Chia-Ming Chang ¹, Huey-Hong Hsieh ², Yu-Hui Chou ³ and Hsiu-Chin Huang ^{4,*}

- ¹ Department of Physical Education, Health & Recreation, National Chiayi University, Chiayi 62103, Taiwan; gr5166@yahoo.com.tw
² Department of Leisure Management, Taiwan Shoufu University, Tainan 72153, Taiwan; nancylin809@gmail.com
³ Department of Recreation and Leisure Industry Management, National Taiwan Sport University, Taoyuan 404401, Taiwan; alex.yh.chou@ntsu.edu.tw
⁴ Physical Education and Arts School, Chengyi University College, Jimei University, Xiamen 361023, China
* Correspondence: op5166@yahoo.com.tw



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Abstract: The purpose of this study was to examine the relationship between a principal's transformational leadership and creative teaching behavior of physical education teachers at junior and senior high schools in Taiwan (at the individual level) and the cross-level effect on creative teaching behaviors of physical education teachers in an innovative school climate (at the school level) and the moderator effect of an innovative school climate on the relationship between a principal's transformational leadership and creative teaching behaviors of physical education teachers. A total of 800 questionnaires were distributed to physical education teachers at 59 junior and senior high schools and 477 valid surveys were collected for data analysis. Using hierarchical linear modeling, we found that at the individual level, a principal's transformational leadership has a positive impact on creative teaching behaviors of physical education teachers, and at the school level, an innovative school climate has a positive impact on creative teaching behaviors (at the person level) of physical education teachers. An innovative school climate at the school level has no moderating effects on the relationship between a principal's transformational leadership and creative teaching behaviors of physical education teachers. This study provides implications and applications for cross-level studies, and builds the foundation for future multilevel research.

Keywords: physical education teachers; transformational leadership; creative teaching; hierarchical linear modeling

1. Introduction

The 21st century has become part of the era of innovation economics, in which there are three characteristics: fierce competition of globalization, rapid technological evolution, and unlimited business opportunities. Therefore, in an innovation economy, enterprises must have innovative employees to maintain a competitive advantage. Their innovation abilities must start in schools, where teachers train students to have problem-solving abilities [1]. In order to respond to the needs of this creative economic era, many countries, such as the United States, Singapore, and Hong Kong, have White Paper on Education Policy to train students with creativity [2,3].

Some studies have indicated that schools are the most capable of cultivating and supporting students' creativity in a learning environment, in which teachers can design systematic teaching programs with creative teaching (CT) methods, through new ideas, new methods, new teaching materials, and new evaluation tools to enhance students'

interest in learning, and thus cultivate students' creative thinking ability [4,5]. Chen and Hu [6] stated that CT performance is an external teaching behavior in which teachers show their creativity in teaching activities. Cremin [7] and Horng et al. [8] described CT as the act of teaching in a novel and useful way that promotes student growth related to the development of original thought and action. CT focuses on both the methods a teacher uses to deliver learning and the overall effect those methods have on students and the outcomes they produce. In recent years, there have been many studies that focused on the study of teachers' CT behaviors because, for students, teachers play an important role in school education by guiding students to learn and stimulating students' creative thinking [9]. For teachers, CT enables teachers to enjoy their work, and they believe that CT is also a challenge to try new teaching methods, which can also build their self-esteem [6,10–12]. Therefore, CT is beneficial to both teachers and students.

Since CT can contribute to students' learning significantly, in this study, we explore some factors affecting teachers' CT behaviors based on related previous studies. In addition, we adopt a multilevel analysis technique to explore the factors that impact on teachers' CT behaviors at both the individual level and the school level. Some studies have suggested transformational leadership, school innovation climate, as well as teachers' and principals' variables may exert influences on CT. Therefore, in the following sections, we briefly introduce the factors related to CT based on previous studies and we also derive the theoretical research framework based on the reasoning of the relationships among those factors.

1.1. Transformational Leadership and Creative Teaching

School principals exercise significant influence on teachers' professional development [13]. In schools today, adapting to cultural and technological changes, pursuing high-quality education, and developing school performance rely on successful leadership from principals [14,15]. Chen and Tsai [16] stated, "As is the principal, so is the school. As is the school, so is the teacher. As is the teacher, so is the student." This statement clearly explains the close relationship among principals, teachers, and students in which the leadership of principals has profound influences on the development of schools [17].

Transformational leadership is a new form of leadership model proposed by Burns [18], which is a type of leadership style that originated from Maslow's psychological demand level theory. Transformational leaders use their personal leadership style to motivate teachers, present and share their forward-looking vision with school members, enhance the needs of the organization members at a higher level, and enable members of an organization to transcend their personal interests to jointly achieve the goals of schools. Therefore, transformational leadership is the key to effectively stimulate school effectiveness [19] and an important incentive to improve school competitiveness [20]. Therefore, in this study, we explore the impact of principal's transformational leadership on high school physical education teachers' CT behavior.

1.2. School Innovative Climate and Creative Teaching

In an enterprise, an organizational innovative climate refers to a work environment in which members of the organization perceive they are supported by inspired innovation in the work environment, and the degree of innovation in the work area [21]. Bharadwaj [22] described that an organizational innovative climate is a climate created by an organization that provides encouragement, rewards, and the needed resources to encourage employees' creative behaviors. A climate of innovation in a school refers to the teachers' innovative perceptions of their school's working environment, such as encouragement from their superiors, adequate school resources, and the level of administrative support [23]. According to Yu [24], he suggested that in order to enhance the development of teachers' CT performance, schools should review teachers' CT teaching methods on a regular basis, and also pay more attention to creating innovative school climates. Empirical studies have found that an innovative school climate belongs at the school level and not the individual

level, and that an innovation school climate has an important positive impact on CT performance [25]. Therefore, in this study, we hope to further explore the impact of an innovative school climate on the CT behavior of physical education teachers in high schools.

1.3. Research Framework

Considering the above-mentioned information, in this study, we adopt a multilevel analysis and design, take principals' transformation leadership and the public high school physical education teachers' CT behaviors as the individual level variables, analyze the influence of a principal's transformation leadership on the high school physical education teachers creative teaching behaviors, and use an innovative school climate as the school level variable, analyze its cross-level influence on high school physical education teachers' CT behaviors, and explore whether an innovative school climate has a moderating effect between a principal's transformational leadership and teachers' CT behaviors. Figure 1 presents the research framework of this study.

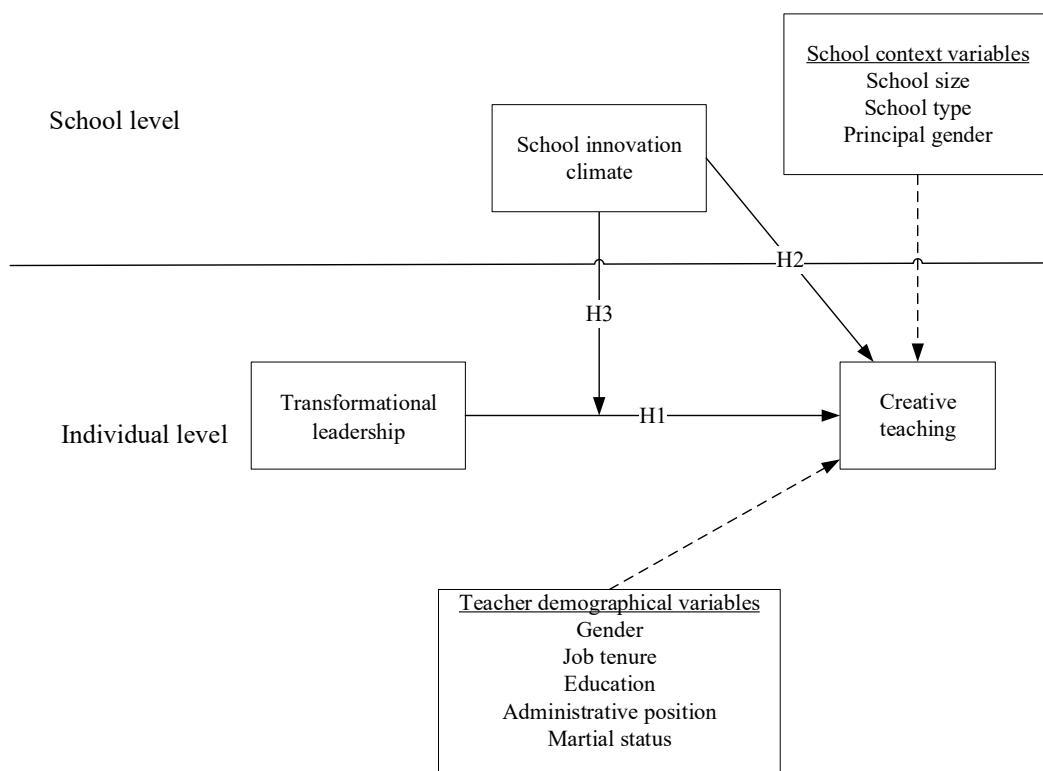


Figure 1. Research framework ("H" denotes hypothesis and "—" denotes control variables' influence).

2. Materials and Methods

According to the research framework, in this section, we introduce the research procedure, which includes participants, survey instruments, and data analysis methods.

2.1. Participants

In this study, physical education teachers in junior and senior high schools in Taiwan were the study subjects. Concerning the research ethics [26], this survey was approved by the National Cheng Kung University Institutional Review Board (IRB). The IRB number is NCKU-HREC-E-107-432-2. Proportional stratified sampling was used and 100 schools were selected as the survey units. A total of 800 questionnaires were distributed to the selected schools from 5 March 2020 to 20 June 2020. Before the investigation, all participants agreed to sign a consent form and 477 valid surveys from 59 school were collected with a 59.95% return rate.

2.2. Research Instruments

We used a questionnaire to collect information which was divided into five parts that included a transformational leadership scale, creative teaching scale, innovative school climate scale, demographic variables, and control variables. In the following sections, we elucidate the formulation of the scales and the tests for reliability and validity of the scales are described.

2.2.1. Transformational Leadership Scale

The transformational leadership scales developed by Tu [25], Chin and Wu [27], Jantzi and Leithwood [28], and Kathleen [29] were modified and used in this study, which consisted of five subscales with four items in each subscale. The five subscales were: idealized attributes, idealized behaviors, inspirational motivation, intellectual stimulation, and individualized consideration. Each item was measured on a 5-point Likert-type scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The reliability of the scale were tested using confirmatory factor analysis. The results showed that the five-factor measurement model had a good fit ($\chi^2 = 221.69$ ($p < 0.05$), RMR = 0.02, RMSEA = 0.06, CFI = 0.99, and $\chi^2/\text{df} = 2.61$). The statistics illustrated that the model fit well to the data. The average variance extracted (AVE) for each construct was above 0.50, which supported the convergent validity of the measures. Discriminant validity was confirmed as follows: the square root of the AVE was larger than the corresponding correlation coefficient between factors. With respect to reliability, the internal consistency showed that the Cronbach alpha values of 0.82 for idealized attributes, 0.85 for idealized behaviors, 0.89 for inspirational motivation, 0.90 for intellectual stimulation, and 0.93 for individualized consideration confirmed high internal consistent reliability for this transformational leadership scale survey questionnaire.

2.2.2. Creative Teaching Scale

In this study, we used the CT scale from Chen and Hu [6] which was originally developed by Scott and Bruce [30] and modified it to fit a teaching environment. This scale was comprised of six items which included “new ideas”, “new schemes”, “updated materials”, and “new evaluation tools”. One item included, “I am willing to try new teaching schemes to improve teaching quality.” Each item was measured on a 5-point Likert-type scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The reliability of the scale were tested using confirmatory factor analysis. The results showed that the five-factor measurement model had a good fit ($\chi^2 = 30.92$ ($p < 0.05$), RMR = 0.01, RMSEA = 0.08, CFI = 0.99, and $\chi^2/\text{df} = 3.87$). All factor loadings ranged from 0.68 to 0.85, which met the requirement of validity (factor loading > 0.5). With respect to reliability, the internal consistency showed that the Cronbach alpha value was 0.91, which indicated high internal consistent reliability.

2.2.3. School Innovation Climate Scale

In this study, we used the organization innovation scale from Yu [23] which was modified from the Amabile’s organization innovation scale [31]. The scale is comprised of two constructs, i.e., “creative reward” and “creative support”. Each construct contains four items. For “creative reward”, one item was “Creative teaching ideas are welcomed in school” and, for “creative support”, one item was “Creative tasks are praised by administrative leaders.” Each item was measured on a 5-point Likert-type scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The results showed that the five-factor measurement model had a good fit ($\chi^2 = 47.09$ ($p < 0.05$), RMR = 0.01, RMSEA = 0.04, CFI = 0.99, and $\chi^2/\text{df} = 2.62$). All factor loadings ranged from 0.62 to 0.78, which met the requirement of validity. With respect to reliability, the internal consistency showed that the Cronbach alpha values were 0.81 for creative reward and 0.85 for creative support, which indicated high internal consistent reliability for this organization innovation scale survey questionnaire.

2.2.4. Demographic Variables

The sociodemographic variables at an individual level included: teacher's gender, job tenure, age, administration experience, marital status; at the school level, the variables included school type, school size, and principal's gender.

2.2.5. Control Variables

In this study, the control variables were treated at two levels, namely, at the individual level and at the school level. First, at the individual level, principal's gender, teacher's gender, teacher's marital status, and job tenure have been found to have positive impacts on principals' transformational leadership and teachers' CT [16,32–34]. Regarding an innovative school climate, previous studies have suggested that teacher's gender, school size, school type, teacher's marital status, teacher's age, and administrative engagement are control variables that affect innovative school climate [35–37]. Among the control variables, teacher's age and job tenure are highly correlated, therefore, teacher's age was excluded from the control variables. In summary, teacher's gender, teacher's marital status, education, job tenure, and administrative engagement were selected as control variables. Second, at the school level, school type, school size, and principal's gender were selected as control variables.

2.2.6. Data Analysis

The collected data were analyzed using SPSS 21.0 for Windows and HLM 7.0. The statistical test for significant level was set as $p < 0.05$. The statistical analyses were preformed which included descriptive statistics, Pearson's correlation analysis, and hierarchical linear modeling (HLM). The descriptive analyses and Pearson's correlation analysis were performed to examine the nature of the collected data and correlations among variables and the HLM analysis were performed to test the proposed hypotheses and identify the intraclass impacts of an innovative school climate on individual teacher's CT behavior.

3. Results

3.1. Correlations and Descriptive Statistics

According to Klein, Dansereau, and Hall [38], the appropriateness of aggregating individual outcomes to the group level has to be determined prior to conducting HLM. In this study, the school level variable, namely an innovative school climate, was a shared construct in which each school's innovative climate perception value was obtained by aggregating teachers' perceptions, grouped by each individual school. After aggregation, the r_{wg} index was used to test the appropriateness of aggregation [39]. The r_{wg} index is a measure of intraclass agreement; a value of r_{wg} equal to or greater than 0.70 (indicating high consistency in groups) is normally used as the criterion to determine the appropriateness of aggregated data for higher levels of analysis. Bliese [40] suggested another indicator intraclass correlation coefficient (ICC) to test whether the data were appropriate for the HLM analysis. Two types of ICCs can explain the aggregation levels of the data structure: ICC(1) represents the percentage of variance between groups and ICC(2) represents the reliability of the group mean scores. The ICC(1) value must be equal to or greater than 0.07, while ICC(2) values must be equal to or greater than 0.50 [41]. In this study, the averaged r_{wg} of innovative school climate was 0.85 (range from 0.84 to 0.87, SD = 0.27), which was greater than 0.7; the ICC(1) of school innovation climate was 0.16 and ICC(2) was 0.59 which all met the criteria mentioned above. Therefore, the innovative school climate data aggregated from teachers grouped from each individual school could be aggregated into higher levels of analysis.

Table 1 presents the summary statistics of individual and group variables, including relationships between variables using Pearson's coefficient of correlation. At the individual level, the correlations of teachers with administrative position are negatively correlated with education, marital status, and transformational leadership. At the school level, school size is highly correlated with school type.

Table 1. Summary statistics and Pearson's coefficient of correlation of individual- and group-level variables.

Individual Level Variable	M	SD	1	2	3	4	5	6
1. Teacher gender	1.35	0.48	1.00					
2. Job tenure	13.22	8.64	0.02	1.00				
3. Education	2.60	0.51	0.03	0.13 **	1.00			
4. With administrative position	1.70	0.46	0.12 *	-0.07	-0.15 **	1.00		
5. Marital status	1.63	0.48	-0.14 **	0.49 **	0.12 *	-0.12 **	1.00	
6. Transformational leadership	3.71	0.65	-0.10 *	-0.04	0.00	-0.13 **	-0.06	1.00
School level variable			1	2	3	4		
1. School type	1.08	0.28	1.00					
2. School size	45.79	23.89	0.42 **	1.00				
3. Principal gender	1.20	0.41	-0.15	0.00	1.00			
4. Organization innovative climate	3.86	0.28	-0.03	0.05	0.02	1.00		

Note: $n = 477$ at the individual level; $n = 59$ at the school level; M, mean; SD, standard deviation; * $p < 0.05$, ** $p < 0.01$

3.2. Hypothesis Testing

In this study, we proposed three hypotheses and tested them using HLM. Prior to performing HLM, the null model analysis was performed to test the appropriateness of the HLM analysis, and then HLM was performed to test the three hypotheses.

3.2.1. Null Model Analysis

Table 2 presents the results from the null model analysis. The null model is presented in Equations (1) and (2). The results from the χ^2 test indicated that the intraclass variation of teachers' CT behaviors was significant ($\chi^2 = 117.40$, $df = 58$, $p < 0.001$), and the interclass correlation ICC (1) = 0.114, which showed that 11.4% variation of teachers' CT behaviors were accounted for by the school's influence. Therefore, the HLM analysis was performed to test the three hypotheses.

Level-1 Model

$$CT_{ij} = \beta_{0j} + r_{ij} \quad (1)$$

Note: CT: creative teaching.

Level-2 Model

$$\beta_{0j} = \gamma_{00} + u_{0j} \quad (2)$$

Table 2. Summary results from the null model analysis.

Random Effect	Standard Deviation	Variance Component	d.f.	χ^2	p Value
INTRCPT1, u_0 level-1, r	0.201 0.564	0.041 0.318	58	117.40	<0.001

3.2.2. HLM Analysis

The HLM analysis was performed to test the proposed hypotheses using Equations (3) and (4).

Level-1 Model (individual level)

$$CT_{ij} = \beta_{0j} + \beta_{1j} * (\text{gender}_{ij}) + \beta_{2j} * (\text{job tenure}_{ij}) + \beta_{3j} * (\text{education}_{ij}) + \beta_{4j} * (\text{administrative position}_{ij}) + \beta_{5j} * (\text{marital status}_{ij}) + \beta_{6j} * (\text{principal's transformational leadership}_{ij}) + r_{ij} \quad (3)$$

where CT represents creative teaching; unless specified, variables all represent teachers' perceptions; j represents the index of school; i represents the index within the school j , where $j = 1\sim 59$; the value of principal's transformational leadership was centered around the group mean.

Level-2 Model (school level)

$$\begin{aligned}\beta_{0j} &= \gamma_{00} + \gamma_{01} * (\text{school type}_j) + \gamma_{02} * (\text{school size}_j) + \gamma_{03} * (\text{principal's gender}_j) + \\ &\quad \gamma_{04} * (\text{school innovative climate}_M_j) + u_{0j} \\ \beta_{1j} &= \gamma_{10} \\ \beta_{2j} &= \gamma_{20} \\ \beta_{3j} &= \gamma_{30} \\ \beta_{4j} &= \gamma_{40} \\ \beta_{5j} &= \gamma_{50} \\ \beta_{6j} &= \gamma_{60} + \gamma_{60} * (\text{school innovative climate}_{ij})\end{aligned}\tag{4}$$

Note: The value of innovative school climate_M was centered around the grand mean.

The HLM analysis was performed based on the above equations. Table 3 presents the results of the HLM analysis. Regarding the control variables at the individual level, the test results showed that, among the six control variables, only teacher's gender affected CT behavior ($\gamma_{10} = 0.15$, $t = -2.48$, $p < 0.05$), which indicated that male teachers showed higher CT behaviors as compared with female teachers. Regarding the control variables at the school level, none of the variables (school size, school type, and principal's gender) affected teachers' CT behaviors. Regarding the proposed hypotheses in the study, at the individual level (H1), a principal's transformational leadership affected teachers' CT behaviors positively ($\gamma_{60} = 0.45$, $t = 6.52$, $p < 0.05$). Regarding the cross-level analysis, the result showed that school innovative climate affected teachers' CT behaviors positively ($\gamma_{04} = 0.56$, $t = 4.92$, $p < 0.05$), therefore, H2 was supported, which indicated that the higher the school innovative climate, the higher the teachers' CT behaviors. Regarding H3, the test results showed that innovative school climate had no significant moderation effects between a principal's transformational leadership and teachers' CT behaviors ($\gamma_{61} = 0.08$, $t = 0.28$, $p > 0.05$).

Table 3. HLM analysis results.

Fixed Effect	Coefficient	Standard Error	t-Ratio	Approx. d.f.	p-Value
For INTRCPT1, β_0					
INTRCPT2, γ_{00}	4.19	0.19	21.83 *	54	<0.001
School type, γ_{01}	-0.03	0.07	-0.46	54	0.649
School size, γ_{02}	-0.00	0.00	-1.66	54	0.102
Principal's gender, γ_{03}	-0.01	0.08	-0.17	54	0.863
School innovation climate, γ_{04}	0.56	0.11	4.92 *	54	<0.001
For teachers' gender slope, β_1					
INTRCPT2, γ_{10}	-0.15	0.06	-2.48 *	411	<0.014
For job tenure slope, β_2					
INTRCPT2, γ_{20}	-0.00	0.00	-0.44	411	0.661
For education slope, β_3					
INTRCPT2, γ_{30}	0.01	0.05	0.31	411	0.757
For administrative position slope, β_4					
INTRCPT2, γ_{40}	0.07	0.05	1.41	411	0.160
For marital status slope, β_5					
INTRCPT2, γ_{50}	-0.09	0.06	-1.65	411	0.101
For transformational leadership slope, β_6					
INTRCPT2, γ_{60}	0.45	0.07	6.52 *	411	<0.001
School innovation climate, γ_{61}	0.08	0.29	0.28	411	0.779

Note: * $p < 0.05$.

4. Discussion

4.1. The Necessity of HLM Analysis

CT can increase students' learning engagement and efficacy. Many studies have explored several factors related to CT, but mostly at the individual level, for example, the relationship of junior high school physical education teachers' work engagement and CT [33] and the effects of senior high school physical education teachers' proficiency and work motivation on CT [42]. However, teachers are affiliated with a school, and they are affected by a school's climate and principal's leadership. Therefore, teachers' behaviors and work outcomes may be affected by individuals or the organization separately and when examining the impacts on teachers' behaviors, these influencing units should consider individual or cross-level impacts separately [43,44]. On the basis of the above-mentioned reasoning, in this study, we designed the multilevel analysis using principals' transformational leadership and teachers' CT as individual variables and innovative school climate as a school level variable to explore the impact of principals' transformational leadership on high school physical education teachers' CT behaviors. In addition, we also used innovative school climate as the school level variable to explore the cross-level impacts on teachers' CT and the moderation effects between principals' transformational leadership and teachers' CT. We collected 477 samples from 59 schools and the null model analysis showed 11.4% variation of CT was caused by school level variables. Therefore, using HLM analysis in the study is validated [45,46].

4.2. Principals' Transformational Leadership and Teachers' Creative Teaching

Previous studies have indicated that traditional teaching, or in other words cramming learning, can lead to low learning efficacy. Therefore, teachers should strive to develop CT skills to increase students' learning motivation [2,47,48]. In this study, a principal's transformational leadership was found to have a positive impact on teachers' CT which indicated that the more a principal adopts transformational leadership, the higher the level of teachers' CT. A principal's transformational leadership was found to contribute to a school's innovation and achieve a school's proposed purposes. This finding was discovered through an annual outstanding principal award sponsored by the Ministry of Education, Taiwan [49]. Wang studied the leadership styles of the awarded principals and concluded that principals who were transformational leaders used their personal charm, inspiration, as well as stimulation of intelligent growth, personal care, and vision sharing to lead and that the more principals performed transformational leadership, the more the teachers were motivated to accept schools' innovations and use CT in their teaching. Therefore, principals can motivate teachers' CT intention through transformational leadership, such as being supportive and encouraging of their efforts to use CT skills in their teaching [49,50].

4.3. School Innovative Climate and Teachers' Creative Teaching

Wu and Yang [41] indicated that the higher the innovative school climate, the higher the level of teachers' CT. An effective and conducive school climate that creates better educational interactions, together with an effective organizational school climate creates time for creativity and innovation, and therefore encourages teachers to become more creative and innovative. An innovative school climate refers to teachers' perceptions of a school's atmosphere in which teachers feel supported and encouraged to be innovative, which enhances teachers' CT behaviors and beliefs. In other words, when teachers perceive a higher innovative school climate, they are more likely to develop CT skills and apply the skills in their teachings. We also showed that an innovative school climate had a positive impact on physical education teachers' CT behaviors. The results suggest that a principal can promote an innovation school climate continuously, in which the principal can set the innovation vision as the school management goal and through transformational leadership can create an innovative school climate, which helps to motivate teachers' and students' creativity and to make teaching and learning enjoyable.

5. Conclusions and Suggestions

5.1. Conclusions

In this study we used an HLM analysis to analyze the relationships among innovative school climate, principals' transformational leadership, and physical education teachers' CT; the control variables at the individual and school level were also examined. In line with our three proposed hypotheses along with control variables, the findings are:

1. The control variable at the individual level of teacher's gender had an impact on CT. Male teachers had higher CT behaviors than female teachers.
2. The control variable at the school level had no impact on CT.
3. At the individual level, a principal's transformational leadership had a positive impact on CT.
4. At the school level, an innovative school climate had a positive impact on CT.

5.2. Suggestions

According to the study results, suggestions are made for school principals, physical education teachers, and policymakers.

5.2.1. Suggestions for Principals

1. Since a principal's transformational leadership had a positive impact on CT, principals can use this leadership style to motivate teachers' CT behavior, for example, principals can encourage, inspire, and care for each individual teacher and lead in CT, which may increase teacher's motivation in CT.
2. An innovative school climate may also affect teachers' CT; therefore, principals can employ transformational leadership to create innovative school climates in which teachers are motivated to practice CT.
3. The results showed that male teachers' CT behaviors were higher than those of female teachers, possibly, due to some family obligations or female characteristics. Therefore, school principals could explore some leadership skills that encourage female teachers or, simply be more supportive of them to engage more CT behaviors.

5.2.2. Suggestions for Physical Education Teachers

Recently, the Ministry of Education, Taiwan has actively promoted teachers' professional growth communities. Through those communities, teachers can interact and cooperate with many teachers. By sharing experiences and working together, they gain innovative ideas, enjoy creative teaching, and feel satisfied and meanwhile. In addition, students can benefit from teachers' CT which results in enjoyment on both sides.

5.2.3. Suggestions for the Education Bureaus

1. From the results of this study, we learned that a school's principal is the key person who can lead a school to innovation and progress. In Taiwan, school principals are assigned by each county or city's Education Bureau. Before being assigned, school principal candidates are evaluated and interviewed by a School Principal Selection Committee. The candidates are required to provide their vision and goals for a school which, of course, are important for a school's development. In addition, we suggest that principals' leadership styles should also be considered, since transformational leadership is crucial to the development of an innovative school climate. Principals with transformational leadership styles can effectively build innovative school climates, encourage and support teachers for their efforts in CT, and therefore are beneficial to both schools and students.
2. Recently, under the impact of the COVID-19 pandemic, the development of 3C Technology has been fast and easy-to use. Teachers can join an exclusive online community in which to share experiences and use modern-day technology to assist their teaching, which would increase students' learning motivation and efficacy.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Ministry of Education, Taiwan and approved by the National Cheng Kung University Institutional Review Board on 15 December 2019. The approved number is NCKU-HREC-E-107-432-2.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data can be provided under requested.

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