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# EXPLORING THE MODEL AND DIFFERENCES OF INNOVATIVE TEACHING EFFICACY: A CASE STUDY OF TAIWAN

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## ABSTRACT

In response to social change and the need for higher education reform, Taiwan's higher education system has made cultivating student innovation an important educational goal. Through the allocation of funds, tertiary institutions have been promoted to become centers of innovation and to create curricula and learning environments for creative education. To achieve this goal, universities provide teachers with funds and resources for innovative teaching to enhance teaching efficacy. This, in turn, affects student learning. Therefore, this study constructed a model of teachers' innovative teaching efficacy encompassing four key dimensions: "Understanding of innovative concepts," "Application of teaching methods," "Creating a teaching atmosphere," and "Implementation of diverse assessments." It further explores the differences in innovative teaching efficacy among teachers from various backgrounds at a science and technology university in Taiwan. A total of 357 valid samples were collected, and quantitative analysis was conducted using descriptive statistics, t-tests, ANOVA, and confirmatory factor analysis (CFA). Regarding reliability and validity, the internal consistency coefficients of the teachers' innovative teaching efficacy scale ranged between 0.75 and 0.85, and the second-order confirmatory factor analysis demonstrated an acceptable model fit and internal quality, indicating that the scale has appropriate reliability and validity. Additionally, the study found that teachers who have applied for innovative teaching-related projects within the previous 3 years, particularly those who are female, aged 41–50 years, with 6 to 10 years of teaching experience, and who hold the rank of professor, exhibit a higher perception of their teaching efficacy. Moreover, educators who applied for innovative teaching projects within this timeframe demonstrated significantly higher overall teaching efficacy. This study has the potential to significantly enhance the teaching efficacy of faculty members in Taiwanese universities, thereby substantially improving educational quality.

***Keywords:*** *innovative teaching, teaching efficacy, higher education*

## Introduction

Cultivating and enhancing creativity has transcended mere importance in addressing the demands of knowledge-based economies, emerging as a critical and indispensable objective in Taiwan. Therefore 2003, the Ministry of Education issued the “White Paper on Creative Education,” establishing creativity education as a key policy initiative (Ministry of Education, 2021). Teachers’ innovative teaching is the key to motivating students to be creative in their performance (Ministry of Education, 2015).

In light of evolving social dynamics, prevailing globalization trends, and anticipated demands for future talent development, the Ministry of Education embarked on a comprehensive overview of pertinent curriculum guidelines. This initiative culminated in the official implementation of the revised guidelines in August 2019. Central to these guidelines is a paradigm shift towards positioning students as the principal agents of their educational journey. By embracing adaptive education, the revised curriculum aims to kindle profound enthusiasm for learning and foster a bold spirit of innovation among students (Ministry of Education, 2021).

Through innovative teaching methods and strategies, teachers can engage students’ attention and stimulate their interest in learning (Zhu et al., 2013). Teachers’ innovative behavior and performance will empower students’ creative thinking and habits, which will be more in line with future trends in education (Chen, 2023). The ultimate goal of school education reform is to enhance students’ learning performance, with teachers’ teaching efficacy being a key factor (Sheu & Ni, 2019). In response to the changing needs of society and in line with the higher education reform policy, the Ministry of Education has been providing grants for individual instructors to conduct research on teaching practices since 2018.

This call for project proposals aimed to encourage instructors to start with the problems and challenges in their classrooms. Supplemented by relevant literature and observations, the research project should propose methods to solve practical issues in teaching, such as incorporating curriculum design, teaching materials, and methods, introducing teaching aids, using technological media, and adopting appropriate research methods and assessment tools to verify teaching efficacy (Ministry of Education, 2024). Although domestic and international universities allocate a considerable proportion of their budgets to teaching, no direct correlation exists between funding and quality. In other words, increased funding or project subsidies do not necessarily lead to tangible improvements in teaching support or efficacy (Lo & Chang, 2020).

Currently, higher education is exploring the influence of teachers’ personality traits and job stress on their teaching efficacy (Chao & Kung, 2021; Klassen & Chiu, 2010; Klassen & Durksen, 2014; Kokkinos, 2007), personality traits (Chen et al., 2001; Kim et al., 2019; Mojsa-Kaja et al., 2015), job stress (Collie et al., 2012; Klassen & Chiu, 2010; Klassen et al., 2013; Karabatak et al., 2018), burnout and job satisfaction (Harmsen et al., 2018; Shi, 2024), learning outcomes (Bandura et al., 2001; Bouih et al., 2021; Nurlu, 2015), and professional learning communities (Lien & Chang, 2017; Thadani et al., 2015; Ting, 2011). However, little research has been conducted on the correlation between participation in innovation-related projects and teaching efficacy. The objectives of this study are as follows:

1. Exploring the latent endogenous variables of first-order constructs such as "Understanding of innovative concepts,” “Application of teaching methods,” “Creating a teaching atmosphere,” and “Implementation of diverse assessments,” and conducting a second-order confirmatory factor analysis of teachers' innovative teaching efficacy while evaluating its reliability and validity.

2. Understanding the current status of innovative teaching efficacy among university faculty members.
3. Comparing the differences in innovative teaching efficacy among teachers from different backgrounds.

This study aims to elucidate university teachers' perceptions of innovative teaching efficacy and to construct a model of innovative teaching efficacy. It rigorously explores the differences in innovative teaching efficacy among teachers with diverse backgrounds. Additionally, the findings from this study will serve as a valuable reference for organizing future teacher competency workshops and seminars, ultimately aimed at bolstering the innovative teaching efficacy of educators.

## Literature Review

### Teaching efficacy

Tschannen-Moran et al. (1998) reported that teachers with high efficacy expend more effort in teaching and show greater persistence in facing obstacles. In addition, they are more likely to try new instructional approaches to find better teaching methods and are more willing to work with students experiencing difficulties. Self-efficacy, introduced by Bandura (1977), refers to "an individual's expectation of success, which influences their determination when facing challenges." Essentially, this is a belief in one's capability to succeed. Ashton et al. (1982) apply Bandura's self-efficacy theory as a foundational framework for teacher efficacy. Denham and Michael (1981) argued that teacher self-efficacy ensures effective teaching. Christensen (1996) posited that teacher self-efficacy, based on the broader concept of self-efficacy, reflects a teacher's belief in their ability to achieve educational objectives for their students. Moneys (1992) defines teaching efficacy as encompassing a teacher's mastery of subject knowledge, effective student communication, friendly and open attitudes, organizational skills, and classroom management techniques. Amabile (1996) noted that a positive classroom atmosphere enhanced students' intrinsic motivation and creativity.

Reynolds et al. (2003) highlighted three primary factors influencing teaching efficacy: professional characteristics, conducive classroom learning environment creation, and strong teaching skills. Effective teachers can design appropriate lesson plans and activities based on students' needs, effectively present materials, and employ suitable teaching methods, strategies, and assessments (Hackmann, 2009). Chang et al. (2014) suggest five key aspects of teaching efficacy: mastering instructional objectives, utilizing teaching strategies, enhancing effective communication, creating a learning environment, and using effective assessment feedback. Chesnut and Burley (2015) defined teaching efficacy as a teacher's ability to induce positive changes in students, foster a supportive atmosphere among students, and guide them in problem-solving and achieving successful experiences. Lai and Liao (2015) analyzed the dimensions of scholars' research about their hiring rates, categorizing teaching efficacy into four areas: teaching planning, teaching strategies, classroom management, and teacher-student interaction. Owing to the numerous factors that influence the teaching process, providing a concise and consistent definition of teaching efficacy is challenging. From the perspective of researchers, it is nevertheless clear that teaching efficacy has a multifaceted meaning.

Various studies have examined the impact of teachers' characteristics and background experience on their teaching efficacy. Chang et al. (2016) found no significant gender-based

differences in teaching efficacy. This result was echoed by Yang (2015), who explored the differences in teaching efficacy among teachers with varying personal background variables, including gender, age, educational attainment, years of service, rank, and teaching unit. Yang's findings revealed no significant differences in teaching efficacy based on these variables, except for teachers in technology-related fields who exhibited higher teaching efficacy than those in the humanities and social sciences.

Chang et al. (2016) investigated the differences in teaching efficacy among vocational high school teachers in the electrical and electronic disciplines based on background variables. Their study found no significant differences in teaching efficacy about gender, educational background, or teaching subject. However, teachers aged 51 years and above showed significantly higher teaching efficacy than those under 40, and teachers with more than 26 years of service exhibited higher efficacy than those with fewer than five years of service. Similarly, Hung and Chen (2015) indicated that teachers who are female, married, and have children aged 28 years and above and those with more service years tend to demonstrate higher teaching efficacy. Lien and Chang (2017) examined beliefs in professional learning communities and their impact on teaching efficacy. They found that elementary school teachers' teaching efficacy varied significantly with differences in years of service and participation in professional learning communities. Chiang et al. (2021) studied the differences in teaching efficacy among clinical teachers in medical centers with different personal background variables. Their results indicated that clinical teachers with more experience and those with workshop training demonstrated higher teaching efficacy.

**Innovative Teaching Efficacy**

The concept of innovation originates from Rogers' (1962) diffusion of innovation theory, which describes the dynamic process by which a new idea, concept, or entity is introduced into a social system over time through specific communication channels. In an educational context, innovation refers to teachers' adoption of new ideas, methods, practices, or assessment approaches to enhance the quality of teaching and learning (Nguyen et al., 2021). Boahene et al. (2019) found a significant correlation between teachers' self-efficacy and innovative practices. Teacher innovation fosters professional development and growth (Gong et al., 2020); this, in turn, helps educators better address teaching challenges, boosting their confidence and teaching efficacy (Chen, 2023).

Fan and Chang (2013) define teaching innovation as a practice wherein teachers, considering educational goals and student needs, effectively use technology to acquire knowledge and apply new teaching concepts in diverse and dynamic ways. This includes changes in teaching content, methods, assessment approaches, and software and hardware facilities to arouse greater student interest and enhance learning outcomes. Hsieh et al. (2016) stated that teacher innovation involves possessing advanced and accurate teaching concepts, utilizing various resources skillfully, and designing instructional activities to meet educational objectives. During the teaching process, it is crucial to consider students' diverse abilities and learning needs, reflect on teaching effectiveness based on current teaching conditions and student feedback, and ensure that learning is enjoyable and effective. To deconstruct the variables of teacher-teaching innovation, they categorized the dimensions of teaching innovation into "concepts," "content," "methods," and "assessment." Yao (2018) defines innovative teaching as introducing new concepts, methods, techniques, tools, and strategies by teachers to facilitate instruction. He categorizes innovative teaching strategies into five dimensions: curriculum materials, teaching philosophy, assessment methods, instructional methods (strategies), and teaching equipment.

Huang (2020) suggested that if teachers adopt diversified teaching methods and varied teaching content during the teaching process to stimulate students' intrinsic learning interests, they can effectively encourage students' proactive learning attitudes and enhance their learning outcomes. Chen (2022) defined innovative teaching efficacy as the perception that teachers who possess innovative ideas can employ creative instructional strategies centered on students, stimulate students' creative thinking abilities within an explorative learning environment, and utilize diverse and appropriate assessment methods to achieve innovative outcomes.

Innovative teaching efficacy encompasses multiple dimensions, and researchers have differing views on the meaning of innovative teaching. Most interpretations focus on aspects such as teaching philosophy, teaching methods, assessment, and instructional organization. The primary objective of this study is to approach the topic from the perspective of innovative teaching and to explore the innovative teaching efficacy scale across four key dimensions: "Understanding of innovative concepts," "Application of teaching methods," "Creating a teaching atmosphere," and "Implementation of diverse assessments." Additionally, this study aims to evaluate the reliability and validity of the scale, positioning it as an important tool for assessing teachers' innovative teaching efficacy within Taiwan's higher education system.

## Methodology

### Instruments

The instruments used in this study were developed based on a comprehensive review of previous research on teaching efficacy. During the conceptualization stage of the scale tool, this study initially distilled the definition of teachers and subsequently synthesized diverse dimensions to measure their teaching efficacy, as shown in Table 1.

Table 1: Research-aspect operational definition

| Construct | Definition | Number | Indicator | Reference sources |
|---|---|---|---|---|
| Understanding of innovative concepts | Teachers are capable of responding to future trends, possessing forward-looking and innovative ideas, possessing a high degree of professionalism, constantly refining new knowledge in education, and demonstrating creativity in educational work. | 4 | I am willing to incorporate innovative teaching methods and adjust content in my courses as needed; I acknowledge the impact of innovative teaching on student learning; I will refer to creatively designed lesson plans from others, design appropriate teaching materials, and apply them in the classroom. | Chang et al. (2014); Chen (2022); Chen (2023); Fan & Chang (2013); Hsieh et al. (2016); Tsai et al. (2012) |
| Application of teaching methods | Teachers can use rich and diversified teaching strategies to enable students to participate in learning actively, stimulate | 3 | I will integrate "interdisciplinary" materials into my teaching curriculum; I will utilize information technology (such as e-books and computers) and Internet | Chen (2022); Chen (2023); Fan & Chang (2013); Reynolds et al. |

| | | | | |
|---|---|---|---|---|
| | innovative thinking and behavior, and achieve the goals of tailor-made teaching and adaptive teaching. | | resources (such as online learning platforms) to search for information on innovative teaching and apply it in my teaching; I will adapt the timing of teaching methods according to the needs of the instructional curriculum. | (2003); Hsieh et al. (2016) |
| Creating a teaching atmosphere | Teachers can create an environment conducive to developing creativity to encourage support or respond to students' needs to enhance the atmosphere of teacher-student interaction and students' innovative learning performance. | 4 | I will use various communication channels (such as discussion forums, LINE, FB, and social media) to convey messages and enhance interaction between teachers and students. I will encourage students to propose creative thinking and solve problems while learning bravely. I will also offer appropriate praise and encouragement to students for their creativity and performance. | Amabile (1996); Chen (2022); Yang (2015); Yeh (2005); Reynolds et al. (2003) |
| Implementation of diverse assessments | Teachers can assess students' learning efficacy through innovative assessment methods according to the teaching objectives, and student's learning needs to serve as a reference for teachers to reflect on innovative teaching and learning. | 4 | I will establish different assessment criteria based on students' learning differences; select appropriate assessment tools (such as practical work, reports, and observations) based on the content of innovative teaching; and design open-ended assignments and reports that require creativity or inspire critical thinking, allowing students to showcase their learning outcomes. | Chen (2022); Chen (2023); Fan & Chang (2013); Hsieh, et al. (2016); Tsai et al. o (2012) |

The teaching efficacy scale comprises 15 items, all measured using a 5-point Likert-type scale ranging from strongly disagree (1 point) to agree (5 points). Higher scores indicate better teaching efficacy.

The reliability scores, indicated by Cronbach's alpha, ranged from 0.748 to 0.854 for all constructs, signifying satisfactory measurement of the variables of interest. This adherence to Nunnally and Berstein's (1994) recommendation suggests that Cronbach's alpha should exceed 0.7 in more mature studies. This indicates that the questionnaire is highly reliable.

**Population and Sample**

The questionnaire for this study was disseminated via the "Innovative Teaching and Learning Center" at a technology university in Taiwan, utilizing a convenience sampling approach. The target population comprised the university's faculty members, who received the survey link and comprehensive instructions outlining the procedural requirements and the overarching objectives of the research. Faculty members were encouraged to participate by completing the questionnaire within the designated timeframe. Conducted between February 14 and March 31, 2023, this survey successfully garnered 357 valid responses, yielding an impressive,

effective response rate of approximately 93.21% (Table 2).

The majority of respondents were female (62.5%). Regarding age distribution, 51.2% were within the 51–60-year-old age range, 29.4% were aged 41–50, 13.2% were over 61, and 6.2% were under 40. Regarding teaching experience, 42.6% had over 21 years, 20.4% had 16–20 years, 14.3% had 11–15 years, 11.8% had less than 5 years, and 10.9% had 6–10 years of experience. Regarding job titles, 38.3% were assistant professors, 35.3% associate professors, and 7.6% lecturers. Regarding the application for teaching innovation-related projects, 56.9% had applied, and 43.1% had not.

Table 2: Respondents' profiles

| Demographics | Level | Count | Percentage |
|---|---|---|---|
| Gender | Male | 233 | 65.3 |
| | Female | 124 | 34.7 |
| Age | below 40 | 22 | 6.2 |
| | 41–50 | 105 | 29.4 |
| | 51–60 | 183 | 51.2 |
| | above 61 | 47 | 13.2 |
| Teaching Seniority | below 5 | 42 | 11.8 |
| | 6–10 | 39 | 10.9 |
| | 11–15 | 51 | 14.3 |
| | 16–20 | 73 | 20.4 |
| | above 21 | 152 | 42.6 |
| Job Title | Lecturer | 27 | 7.6 |
| | Assistant Professor | 137 | 38.3 |
| | Associate Professor | 126 | 35.3 |
| | Professor | 67 | 18.8 |
| Apply for teaching innovation-related projects | Not applied | 154 | 43.1 |
| | Applied | 203 | 56.9 |

## Data Analysis

Quantitative data analysis was performed using SPSS version 25.0 and AMOS 28.0. The statistical methods employed in this study are described below.

1. Descriptive statistical analysis: Using measures such as means and standard deviations, the characteristics of the sample were examined, providing insights into the average levels and variability of teachers' teaching efficacy.
2. Independent sample t-test: Independent t-test analyses were conducted to detect significant differences among various categories, including gender and application for teaching innovation-related projects within the past 3 years.
3. Analysis of variance (ANOVA): ANOVA was used to detect significant age differences, teaching seniority, and job title.
4. Confirmatory factor analysis (CFA): This study uses second-order confirmatory factor analysis to understand whether the four-component model of innovative teaching

efficacy measured by 15 items is supported by actual data. Teachers' innovative teaching efficacy is a second-order latent exogenous variable, which explains the first-order latent endogenous variables: "Understanding of innovative concepts," "Application of teaching methods," "Creating a teaching atmosphere," and "Implementation of diverse assessments."

## Results

### Validity and Reliability Analysis

**Confirmatory Factor Analysis:** This study used second-order confirmatory factor analysis to examine teachers' innovative teaching efficacy based on four dimensions: "Understanding of innovative concepts," "Application of teaching methods," "Creating a teaching atmosphere," and "Implementation of diverse assessments." The results of this analysis are shown in Figure 1 and described below:

1. Basic model fit test: As depicted in Figure 1, all error variances in this model were positive and significant, with no negative values. The factor loadings ranged from 0.37 to 0.70, with none falling below 0.50 or exceeding 0.95. The second-order factor loadings ranged from 0.83 to 0.95. These results indicate that the model met the basic fit test without identification issues.
2. Overall model fit test: Table 3 presents several model fit indicators and the recommended thresholds. The model demonstrated an excellent fit with the data, as evidenced by the following indices: Chi-square/df ratio ($\chi^2$/df) = 2.28, Root Mean Square Error of Approximation (RMSEA) = 0.06, Comparative Fit Index (GFI) = 0.93, and Adjusted Goodness of Fit Index (AGFI)= 0.91. These indices collectively indicate that the proposed model is both parsimonious and accurate in representing the underlying data structure.
3. Component reliability (CR) value of the potential variables: As shown in Table 4, this value reflects the reliability of all measurement variables constituting a particular construct. This measures the internal consistency of the construct indicators, with high values indicating high internal consistency. Chin (1998) suggested a threshold of 0.7 or higher. This study's CR values ranged from approximately 0.77 to 0.86, indicating good internal consistency within the research model.
4. Average variance extracted (AVE) of the potential variables: As shown in Table 4, this measure calculates the variance explanatory power of each measurement variable within the potential variables. High values indicate the potential variables' high discriminant validity and convergent validity. Fornell and Larcker (1981) recommended a minimum threshold of 0.5 for the AVE values. In this study, all the AVE values exceeded 0.5, with the potential variables ranging from 0.53 to 0.60.

In summary, the results of the second-order CFA indicate that the four-component model of teachers' innovative teaching efficacy, measured by 15 items, does not violate basic fit standards and possesses acceptable internal quality and overall model fit.

Table 3: Model fit

| Model fit | Criteria | Model fit of the research model |
|---|---|---|
| $\chi^2$/df | $1 < \chi^2/df < 3$ | 2.28 |
| RMSEA | < 0.08 | 0.06 |
| GFI | > 0.9 | 0.93 |
| AGFI | > 0.9 | 0.91 |

Table 4: Construct reliability results

| Construct | Items | Loadings | CR | AVE |
|---|---|---|---|---|
| Understanding of innovative concepts | I am willing to incorporate innovative teaching methods and adjust content in my courses as needed. (T1) | 0.81 | 0.86 | 0.60 |
| | I will refer to creatively designed lesson plans from others, design appropriate teaching materials, and apply them in the classroom. (T2) | 0.73 | | |
| | I will integrate relevant course materials and transform and design creative teaching content to achieve innovative teaching objectives. (T3) | 0.82 | | |
| | I will design a curriculum (including activities) to enhance student learning. (T4) | 0.74 | | |
| Application of teaching methods | I will integrate "interdisciplinary" materials into my teaching curriculum. (T5) | 0.62 | 0.77 | 0.53 |
| | I will utilize information technology (such as e-books and computers) and Internet resources (such as online learning platforms) to search for information on innovative teaching and apply it to my teaching. (T6) | 0.72 | | |
| | I will adapt the timing of the teaching methods according to the instructional curriculum's needs. (T7) | 0.82 | | |
| Creating a teaching atmosphere | I will use various communication channels (such as discussion forums, LINE, FB, and social media) to convey messages and enhance interaction between teachers and students. (T8) | 0.66 | 0.86 | 0.60 |
| | I encourage students to propose creative thinking and solve problems while learning bravely. (T9) | 0.82 | | |
| | I will promptly praise and encourage students for their creativity and performance. (T10) | 0.82 | | |
| | I will respect and encourage the unique performances of individual students. (T11) | 0.79 | | |
| Implementation of diverse assessments | I will establish different assessment criteria based on students' learning differences. (T12) | 0.61 | 0.82 | 0.54 |
| | I will select appropriate assessment tools (such as practical work, reports, and observations) based on the content of innovative teaching. (T13) | 0.84 | | |
| | I will design open-ended assignments and reports requiring creativity or inspiring critical thinking, allowing students to showcase their learning outcomes. (T14) | 0.81 | | |
| | I will share my creative achievements in teaching with other teachers. (T15) | 0.66 | | |

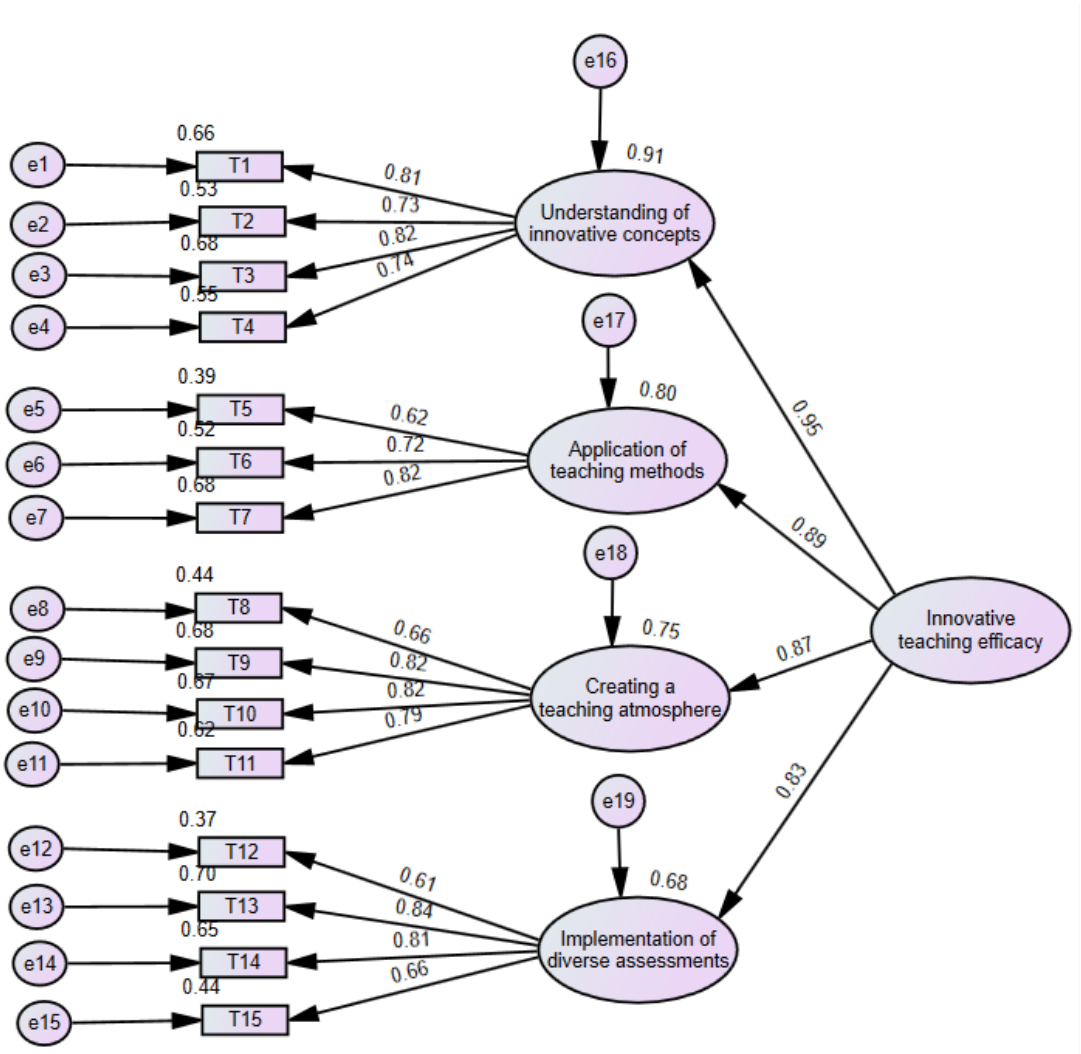


Figure 1: Second-order confirmatory factor analysis model of innovative teaching efficacy

**Internal Consistency Analysis:** The internal consistency analysis of the Teacher Innovative Teaching Efficacy Scale, along with its four sub-dimensions—"Understanding of Innovative Concepts," "Application of Teaching Methods," "Creating a Teaching Atmosphere," and "Implementation of Diverse Assessments"—produced Cronbach's α coefficients of 0.854, 0.748, 0.849, and 0.812, respectively. With most of these values exceeding 0.80, the results indicate a high level of reliability, indicating that the scale demonstrates good reliability.

**Analysis of the Average Innovative Teaching Efficacy**

As shown in Table 5, the overall average score for innovative teaching efficacy was 4.40, with the average scores for each item and factor measuring teaching efficacy exceeding 3.5. Most items scored above 4, with the highest score being 4.61. Notably, several items demonstrated exceptionally high satisfaction with scores above 4.5. These items include "1. I am willing to incorporate innovative teaching methods and adjust content in my courses as needed" (M = 4.53), "6. I will utilize information technology (such as e-books and computers) and Internet resources (such as online learning platforms) to search for information on innovative teaching, and apply it in my teaching" (M = 4.51), "7. I will adapt the timing of the teaching methods according to the instructional curriculum's needs" (M = 4.52), "9. I

encourage students to bravely propose creative thinking and solve problems during learning" (M = 4.59), "10. I will timely offer appropriate praise and encouragement to students for their creativity and performance" (M = 4.61), and "11. I will respect and encourage the unique performances of individual students" (M = 4.60) and "Factor 3 and creating a teaching atmosphere" (M = 4.57).

Table 5: Average score of each item and factor for innovative teaching efficacy

| Item and Factor | | M | SD |
|---|---|---|---|
| 1. | I am willing to incorporate innovative teaching methods and adjust content in my courses as needed. | 4.53 | 0.61 |
| 2. | I will refer to creatively designed lesson plans from others, design appropriate teaching materials, and apply them in the classroom. | 4.45 | 0.63 |
| 3. | I will integrate relevant course materials and transform and design creative teaching content to achieve innovative teaching objectives. | 4.36 | 0.63 |
| 4. | I will design a curriculum (including activities) to enhance student learning. | 4.38 | 0.69 |
| 5. | I will integrate "interdisciplinary" materials into my teaching curriculum. | 4.27 | 0.77 |
| 6. | I will utilize information technology (such as e-books and computers) and Internet resources (such as online learning platforms) to search for information on innovative teaching and apply it to my teaching. | 4.51 | 0.61 |
| 7. | I will adapt the timing of the teaching methods according to the instructional curriculum's needs. | 4.52 | 0.56 |
| 8. | I will use various communication channels (such as discussion forums, LINE, FB, and social media) to convey messages and enhance interaction between teachers and students. | 4.46 | 0.66 |
| 9. | I encourage students to propose creative thinking and solve problems while learning bravely. | 4.59 | 0.60 |
| 10. | I will promptly offer appropriate praise and encouragement to students for their creativity and performance. | 4.61 | 0.57 |
| 11. | I will respect and encourage the unique performances of individual students. | 4.60 | 0.55 |
| 12. | I will establish different assessment criteria based on students' learning differences. | 4.03 | 0.81 |
| 13. | I will select appropriate assessment tools (such as practical work, reports, and observations) based on the content of innovative teaching. | 4.39 | 0.63 |
| 14. | I will design open-ended assignments and reports requiring creativity or inspiring critical thinking, allowing students to showcase their learning outcomes. | 4.32 | 0.73 |
| 15. | I will share my creative achievements in teaching with other teachers. | 4.06 | 0.79 |
| Factor 1 | Understanding of innovative concepts | 4.43 | 0.53 |
| Factor 2 | Application of teaching methods | 4.43 | 0.53 |
| Factor 3 | Creating a teaching atmosphere | 4.57 | 0.49 |
| Factor 4 | Implementation of diverse assessments | 4.20 | 0.59 |
| Overall | Innovative teaching efficacy | 4.40 | 0.47 |

## Analysis of Differences in Innovative Teaching Efficacy

**Gender:** Table 6 shows the average scores for different genders. Female teachers exhibit higher average scores than male teachers in most sub-factors and overall innovative teaching efficacy. The t-test revealed that the difference was not statistically significant.

Table 6: T-test analysis for different gender

| Factor | Male | Female | t |
|---|---|---|---|

| | (n=233) | | (n=124) | | |
|---|---|---|---|---|---|
| | M | SD | M | SD | |
| Factor 1: Understanding of innovative concepts | 4.41 | 0.52 | 4.46 | 0.57 | -0.81 |
| Factor 2: Application of teaching methods | 4.40 | 0.53 | 4.49 | 0.53 | -1.58 |
| Factor 3: Creating a teaching atmosphere | 4.56 | 0.48 | 4.59 | 0.51 | -0.60 |
| Factor 4: Implementation of diverse assessments | 4.20 | 0.57 | 4.20 | 0.64 | 0.11 |
| Overall innovative teaching efficacy | 4.39 | 0.45 | 4.43 | 0.50 | -0.74 |

**Applying for teaching innovation-related projects:** From the average scores of innovative teaching efficacy over the past 3 years, it is evident that teachers who applied for teaching innovation-related projects scored higher on the overall teaching efficacy scale and all subdimensions than those who did not apply for such projects. Through t-test analysis, it was found that the average scores of teachers who applied for innovative teaching innovation projects were significantly higher in the sub-factors of "Understanding of innovative concepts" and "Creating a teaching atmosphere," as well as in "Overall teaching efficacy," compared to those who did not apply for such projects (Table 7).

Table 7: t-test analysis for different applications for teaching innovation-related projects

| **Factor** | **Not applied (n=154)** | | **Applied (n=203)** | | **t** |
|---|---|---|---|---|---|
| | M | SD | M | SD | |
| Factor 1: Understanding of innovative concepts | 4.34 | 0.54 | 4.49 | 0.52 | -2.56* |
| Factor 2: Application of teaching methods | 4.37 | 0.53 | 4.47 | 0.53 | -1.77 |
| Factor 3: Creating a teaching atmosphere | 4.49 | 0.54 | 4.62 | 0.45 | -2.47* |
| Factor 4: Implementation of diverse assessments | 4.14 | 0.59 | 4.24 | 0.59 | -1.60 |
| Overall, innovative teaching efficacy | 4.34 | 0.48 | 4.46 | 0.45 | -2.45* |

* $p < 0.05$

**Age:** Table 8 presents the average scores for different age groups of teachers, showing that teachers aged 41–50 years had the highest average innovative teaching efficacy in overall teaching innovative efficacy (M = 4.44) and the sub-factors "Creating a teaching atmosphere" (M = 4.59) and "Implementation of diverse assessments" (M = 4.28). Conversely, teachers aged > 61 years scored highest in the sub-factors "Understanding of innovative concepts" (M = 4.49) and "Application of teaching methods." (M = 4.47). The ANOVA results indicated no significant differences in the four sub-scales and the overall innovative teaching efficacy across different age groups, with F values of 0.47, 0.11, 0.51, 0.98, and 0.43, respectively (Table 9).

Table 8: Average scores for different ages

| **Factor** | below 40 **(n=22)** | | 41–50 **(n=105)** | | 51–60 **(n=183)** | | above 61 **(n=47)** | |
|---|---|---|---|---|---|---|---|---|
| | M | SD | M | SD | M | SD | M | SD |
| Factor 1: Understanding of innovative concepts | 4.35 | 0.46 | 4.45 | 0.53 | 4.41 | 0.54 | 4.49 | 0.53 |
| Factor 2: Application of teaching methods | 4.39 | 0.49 | 4.43 | 0.53 | 4.43 | 0.53 | 4.47 | 0.55 |
| Factor 3: Creating a teaching atmosphere | 4.45 | 0.49 | 4.59 | 0.51 | 4.57 | 0.48 | 4.54 | 0.52 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Factor 4: Implementation of diverse assessments | 4.15 | 0.49 | 4.28 | 0.62 | 4.16 | 0.60 | 4.22 | 0.55 |
| Overall innovative teaching efficacy | 4.33 | 0.40 | 4.44 | 0.48 | 4.39 | 0.47 | 4.43 | 0.45 |

Table 9: ANOVA analysis for different ages

| Factor | Sum of Squares | F | Sig. | Post-hoc test |
|---|---|---|---|---|
| Factor 1: Understanding of innovative concepts | 0.40 | 0.47 | 0.70 | Not significant for all |
| Factor 2: Application of teaching methods | 0.10 | 0.11 | 0.95 | |
| Factor 3: Creating a teaching atmosphere | 0.37 | 0.51 | 0.68 | |
| Factor 4: Implementation of diverse assessments | 1.03 | 0.98 | 0.40 | |
| Overall, innovative teaching efficacy | 0.28 | 0.43 | 0.73 | |

Table 10: Average scores for different teaching seniority

| Factor | below 5 (n=42) | | 6–10 (n=39) | | 11–15 (n=51) | | 16–20 (n=73) | | above 21 (n=152) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | M | SD | M | SD | M | SD | M | SD | M | SD |
| Factor 1: Understanding of innovative concepts | 4.33 | 0.50 | 4.41 | 0.58 | 4.45 | 0.55 | 4.40 | 0.54 | 4.46 | 0.52 |
| Factor 2: Application of teaching methods | 4.36 | 0.52 | 4.49 | 0.57 | 4.39 | 0.55 | 4.46 | 0.51 | 4.44 | 0.52 |
| Factor 3: Creating a teaching atmosphere | 4.56 | 0.44 | 4.58 | 0.57 | 4.52 | 0.48 | 4.57 | 0.54 | 4.58 | 0.48 |
| Factor 4: Implementation of diverse assessments | 4.17 | 0.58 | 4.31 | 0.64 | 4.17 | 0.57 | 4.17 | 0.65 | 4.21 | 0.57 |
| Overall, innovative teaching efficacy | 4.35 | 0.41 | 4.44 | 0.54 | 4.38 | 0.46 | 4.40 | 0.49 | 4.42 | 0.46 |

**Teaching seniority:** Table 10 illustrates the average scores for different levels of teaching seniority, revealing that teachers with 6–10 years of experience exhibit the highest average innovative teaching efficacy in overall innovative teaching efficacy (M = 4.44) and the sub-factors of "Application of teaching methods" (M = 4.49) and "Implementation of diverse assessments" (M = 4.31). Conversely, teachers with more than 21 years of seniority scored highest in the sub-factor of "Understanding of innovative concepts" (M =4.47). Notably, "Creating a teaching atmosphere" is a domain where teachers with 6–10 years of experience and those with over 21 years of seniority scored the highest. Furthermore, the ANOVA results indicated no significant differences in the four sub-scales and the overall innovative teaching efficacy across different teaching seniority groups, with F values of 0.61, 0.46, 0.12, 0.44, and 0.28, respectively (see Table 11).

Table 11: ANOVA analysis for different teaching seniority

| Factor | Sum of Squares | F | Sig. | Post-hoc test |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Factor 1: Understanding of innovative concepts | 0.70 | 0.61 | 0.66 | Not significant for all |
| Factor 2: Application of teaching methods | 0.52 | 0.46 | 0.76 | |
| Factor 3: Creating a teaching atmosphere | 0.12 | 0.12 | 0.97 | |
| Factor 4: Implementation of diverse assessments | 0.62 | 0.44 | 0.78 | |
| Overall, innovative teaching efficacy | 0.25 | 0.28 | 0.89 | |

**Job title:** Table 12 illustrates the average scores across different job titles, revealing that the Professor job title exhibited the highest average innovative teaching efficacy in overall innovative teaching efficacy (M = 4.42) and the sub-factors of "Understanding of innovative concepts" (M = 4.46) and "Creating a teaching atmosphere" (M = 4.61). In contrast, The Lecturer's job title scored the highest in the sub-factor of "Application of teaching methods" (M = 4.49), while the Associate Professor led in the sub-factor of "Implementation of diverse assessments" (M = 4.22). Additionally, ANOVA analysis demonstrates no significant differences in the four sub-scales and the overall innovative teaching efficacy across different job title groups, with F values of 0.35, 0.20, 0.39, 0.10, and 0.06, respectively (see Table 13).

Table 12: Average scores for different job titles

| Factor | Lecturer (n=27) | | Assistant Professor (n=137) | | Associate Professor (n=126) | | Professor (n=67) | |
|---|---|---|---|---|---|---|---|---|
| | M | SD | M | SD | M | SD | M | SD |
| Factor 1: Understanding of innovative concepts | 4.43 | 0.56 | 4.39 | 0.52 | 4.45 | 0.55 | 4.46 | 0.53 |
| Factor 2: Application of teaching methods | 4.49 | 0.52 | 4.42 | 0.53 | 4.44 | 0.56 | 4.41 | 0.49 |
| Factor 3: Creating a teaching atmosphere | 4.55 | 0.47 | 4.58 | 0.49 | 4.54 | 0.51 | 4.61 | 0.49 |
| Factor 4: Implementation of diverse assessments | 4.19 | 0.65 | 4.18 | 0.58 | 4.22 | 0.60 | 4.20 | 0.59 |
| Overall, innovative teaching efficacy | 4.41 | 0.47 | 4.39 | 0.45 | 4.41 | 0.49 | 4.42 | 0.46 |

Table 13: ANOVA analysis for job title

| Factor | Sum of Squares | F | Sig. | Post-hoc test |
|---|---|---|---|---|
| Factor 1: Understanding of innovative concepts | 0.30 | 0.35 | 0.79 | Not significant for all |
| Factor 2: Application of teaching methods | 0.17 | 0.20 | 0.90 | |
| Factor 3: Creating a teaching atmosphere | 0.29 | 0.39 | 0.76 | |
| Factor 4: Implementation of diverse assessments | 0.10 | 0.10 | 0.96 | |
| Overall, innovative teaching efficacy | 0.04 | 0.06 | 0.98 | |

## Discussion and Conclusion

This study explored the relationship between university teachers' participation in innovative teaching-related projects and their teaching efficacy. After an extensive literature review, the "Innovative Teaching Efficacy Survey Questionnaire" was constructed as a data collection instrument. The survey data were analyzed in alignment with the research objectives. Based on these findings, the following conclusions were drawn.

1. The results of second-order confirmatory factor analysis indicated that the innovative teaching efficacy model did not violate basic fit tests and exhibited an acceptable overall fit and internal quality. This demonstrates that empirical data support the theoretical construction of the innovative teaching efficacy scale. Regarding reliability, the internal consistency coefficients for all participants across the four sub-dimensions ranged from 0.75 to 0.85, indicating that the innovative teaching efficacy scale possesses good reliability. The findings suggest that the innovative teaching efficacy scale has both strong reliability and acceptable validity, effectively measuring teachers' perceptions of their innovative teaching efficacy across the four dimensions.
2. The overall status of innovative teaching efficacy among university faculty members is commendable, with performance indicators reflecting above-average levels of efficacy. The scores for the various dimensions are ranked, from highest to lowest, as follows: "Creating a teaching atmosphere," "Understanding of innovative concepts," "Application of teaching methods," and "Implementation of diverse assessments." These findings are consistent with the results mentioned by Fan and Chang (2013), which highlight that innovative changes in teaching content, methods, assessment approaches, and software and hardware facilities can stimulate greater student interest and enhance learning outcomes. Additionally, the results showing no significant differences in age, teaching seniority, and job titles are similar to those of Yang (2015), except for the observation that teachers in technology-related fields exhibit significantly higher teaching efficacy than those in the humanities and social sciences.
3. Based on scores of various dimensions of teaching efficacy from different backgrounds, the study found that teachers who applied for innovative teaching-related projects within the previous three years, female teachers aged 41–50, and professors with 6–10 years of teaching experience exhibited higher perceptions of their teaching efficacy.
4. The efficacy of innovative teaching among educators varies significantly based on whether it has been applied to innovative teaching-related projects in the past three years. The research findings indicate that teachers engaged in such projects during this period demonstrate notably higher teaching efficacy on the overall efficacy scale and in the sub-dimensions of "Understanding of innovative concepts" and "Creating a teaching atmosphere." In addition, the differential analysis results indicated no significant differences in gender, age, teaching seniority, or job title. Regarding gender, our findings are consistent with those of Chang et al. (2016) and Yang (2015), who found no significant gender differences in teaching efficacy.

## Implications

This study is grounded in relevant theoretical frameworks and has significant academic and practical implications. Teacher efficacy is pivotal for enhancing student learning outcomes. The overall findings indicate that innovative teaching efficacy is robust, with dimensions such as "Creating a teaching atmosphere," "Understanding of innovative concepts," "Application of teaching methods," and "Implementation of diverse assessments" all receiving average scores exceeding 4 points. Notably, the "Creating a teaching atmosphere" dimension scored the highest, suggesting that teachers excel at fostering effective communication and interaction with students, encouraging innovative thinking, providing timely praise and encouragement for creativity, and respecting and encouraging unique student performance, thereby creating a harmonious and proactive learning environment. Universities should also address areas of low teaching efficacy. The dimension with the lowest average score was "Implementation of diverse assessments." While prioritizing teaching innovation, schools

should actively organize teacher-development activities focusing on low-scoring items to enhance teachers' knowledge and skills using diverse assessment methods.

A comparative analysis of teaching efficacy across different backgrounds revealed significant differences based on whether the teachers had applied for teaching innovation-related projects over the past three years. The dimensions of “Understanding of innovative concepts” and “Creating a teaching atmosphere” were notably higher among those who had applied. Empirical data analysis confirmed the university’s success in promoting innovative teaching projects, particularly in enhancing the teaching atmosphere and understanding innovative concepts. The university prioritizes innovative teaching and has established an Innovative Teaching and Learning Center dedicated to promoting innovative teaching practices. This center organizes relevant development activities, provides funding for innovative teaching projects, and includes these efforts in teacher performance evaluations.

The university can leverage the demonstrated efficacy of teachers who have applied for innovation-related projects over the past three years. By facilitating peer exchanges on innovative teaching practices and publicly recognizing and rewarding outstanding teachers, universities can attract more faculty members to engage in innovative teaching, thereby diffusing teaching efficacy. Furthermore, universities can continuously refine their reward systems by promoting increased funding, additional resources, or enhanced performance points to encourage more teachers to apply for innovative teaching projects. This incentivizes teachers to be dedicated to teaching innovation, giving them the courage to persist in demonstrating teaching efficacy.

Additionally, the analysis of average teaching efficacy scores across different teacher backgrounds indicated that younger teachers (under 40 years old), those with less teaching experience (less than five years), and those with lower academic ranks (associate professors) were less confident in their teaching abilities. Universities should encourage new teachers to participate in innovative teaching activities and projects, enabling them to grasp the key points of curriculum design and diverse assessment mechanisms quickly, thereby promoting their professional development.

## Limitations

The principal strength of this study lies in its comprehensive examination of the efficacy of innovative teaching practices among university faculty members and the impact of participation in related innovative teaching programs on teaching effectiveness. However, this study has certain limitations that warrant exploration.

The first limitation of the current study pertains to the assessment employed. Using a Likert scale to gauge respondents’ perceptions of various variables necessitates reliance on subjective judgment and retrospective completion. Consequently, the collected data may have exhibited discrepancies and biases. To address this issue, qualitative interviews with faculty members could provide a deeper understanding of the empirical findings regarding teaching efficacy.

The second limitation inherent in this study pertains to the indicators employed, which are articulated in the future tense with statements such as "I will." Such temporal framing raises concerns regarding the appropriateness of utilizing these indicators to assess teachers' teaching efficacy, as it relies on anticipated behaviors rather than actual performance.

Finally, a third limitation arises because some teachers who participated in the questionnaire did not engage with innovative teaching-related items. This might have led to divergent models of innovative teaching efficacy between the two distinct groups of educators involved in the study. This disparity may obscure a comprehensive understanding of the factors influencing teaching efficacy across varied teaching practices.

## Recommendations

This paper offers several recommendations for future research in this field. This study used questionnaires to assess the comprehensive theoretical model. Future research could explore the inclusion of alternative measurement methods or introduce other significant dimensions and indicators from various sources to enrich the model for subsequent analyses. For instance, adding variables such as learning satisfaction and learning outcomes could contribute to the establishment of a more comprehensive theoretical framework.

Additionally, while this study focused on teachers at science and technology universities, future research could extend its scope to include educators from other universities. This would allow for a comparative analysis of the differences in teaching efficacy across diverse educational institutions.

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# HYBRID LEARNING AT HIGHER EDUCATION INSTITUTION: A NEEDS ANALYSIS FOR SYNERGISTIC SCAFFOLDS

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## ABSTRACT