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Components and Indicators of Innovators Among Primary School Teachers

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Abstract

The objectives of this study were: 1) to study the components and indicators of innovators in primary school teachers, and 2) to examine the consistency of the components model and indicators of innovators in primary school teachers with empirical data. The participants were 220 primary teachers under the Office of the Basic Education Commission in the Northeastern Region. The researcher determined the sample size based on a 20:1 ratio of the number of parameters and used a multi-stage random sampling. The research instrument was a questionnaire for developing elements and indicators of innovator in primary school teachers. The Item-Objective Congruence (IOC) index ranges from 0.80 to 1.00, the discriminatory power using Pearson Product-Moment Correlation ranges from 0.24 to 0.83, and the reliability of the entire instrument, as measured by Cronbach's alpha coefficient (α), is 0.97. Data were analyzed using confirmatory factor analysis (CFA).

The results revealed the following: 1) the elements and indicators of innovators in primary school teachers were identified through a synthesis of relevant documents and research, consisting of (1) initiative, (2) observation and asking questions, (3) interaction with others, (4) applying, and (5) adapting to the situation, with a total of 11 indicators. 2) The examination of the consistency of the components model and indicators of innovators in primary school teachers with empirical data found that ($\chi 2$) was equal to 15.073, the degrees of freedom (df) was equal to 22, the chi-square value is the correlation ($\chi 2$/df) is equal to 0.685. The statistical significance (p-value) was 0.859, and the goodness-of-fit index (GFI) was 0.988. The Relative Harmony Index (CFI) was equal to 1.000. The Harmonic Harmony Index (NFI) was equal to 0.985. The Root Mean Residual Index (RMR) was equal to 0.004. The square root of the mean square of the estimation (RMSEA) was equal to 0.000, indicating that this tool can be used to evaluate the innovators of primary school teachers.

Keywords: innovator, confirmatory factor analysis, primary school teachers

1. Introduction

Education in a transitional era challenges human talents and capacities in an age where technology plays a significant role, resulting in rapid changes across various sectors. Education for the 21st Century emphasizes that we are living in a time of rapid change in an environment where countries are increasingly interconnected, and the education system needs to adapt, not just through occasional reforms, but through continuous improvement to meet the needs of youth, society, and the labor market both now and in the future (UNICEF Thailand, 2019).

Education is, therefore, an important tool for human development, enabling individuals to transform society into a more livable place. Current education must recognize the significance of the local context alongside the knowledge that cannot be acquired solely in the classroom, as many new learning formats have been developed to align with the contemporary world and the unique context of each locality (Chalarak et al., 2021).

Innovation, therefore, becomes essential in the organization of education. It refers to something new or different from the original, which could be an idea, method, or device, such as using the internet for teaching as an educational innovation. Hence, innovation is a new idea, practice, or invention that has never existed before, or it is the development and modification of something that already exists to be more modern and effective, in order to achieve efficiency and effectiveness. Innovation is distinguished by being new, having a proven and tested process, and being accepted for efficient, effective, and economical use in line with its objectives (Meesuwan, 2017). To create a learning society and foster new innovations in student development, it is necessary to develop thought

leaders or leaders who create innovations, also known as "innovators." Innovators are initiators or inventors who have the initiative to produce new and different things, or things that have never been seen before. They are creative, observant, inquisitive, enthusiastic, willing to take risks and try new things, seek knowledge from various networks, and can connect new ideas with previous experiences (Boyd, 2011; Furr & Dyer, 2014). Innovators can be developed from any personality type (Wagner, 2012).

Nowadays, creating citizens to be innovators or people with the ability to learn and adapt to changes quickly. Innovators are, therefore, crucial in leading organizations and are in high demand in the industrial sector (World Economic Forum, 2018). The demand for innovators is increasing today, leading countries to enact economic development policies that encourage the migration of people with innovation skills to enter their workforce, supported by visas, high wages, and welfare states for those with advanced degrees in STEM subjects, such as the EU Talent Mobility Program policy in Europe, Brain Pool in South Korea, and programs in the United States and France, etc. (Das et al., 2020). In order to create a greater number of innovators, teachers are important people and leaders in the classroom who are very important to be ready to move forward and have teacher characteristics that respond to current changes. The teachers must change their role from being a teacher to being a guide and learning along with the students to being a designer teacher, an integrator teacher, a thinker teacher, and an innovator teacher. From the above issues, the researcher is aware and interested in studying the elements and indicators of teacher innovation to identify the necessary elements, allowing teachers and students in the teaching profession to use them as guidelines for training, self-development, student development, and sustainable social development.

2. Objectives

1) To study components and indicators of Innovator in Primary School teachers under the Office of the Basic Education Commission in the Northeastern Region.

2) To examine the consistency of components model and indicators of innovator in primary school teachers under the Office of the Basic Education Commission in the Northeastern Region with empirical data.

3. Scope of the Research

This research is a study of the elements and indicators of innovators of primary school teachers under the Office of the Basic Education Commission in the Northeastern Region. The scope of the research is as follows:

3.1 Scope of Content

Step 1: Study the composition and indicators of innovators among primary school teachers under the Office of the Basic Education Commission in the Northeastern Region.

The researcher studied the elements of innovators from various academics and synthesized them and found that there were 5 elements and 11 indicators as follows: 1) taking initiative, 2) observing and asking questions, 3) interacting with others 4) application and 5) adjustment to the situation (Dyer, Gregersen, & Christensen, 2011; Boyd, 2011; Wagner, 2012; Furr & Dyer, 2014; Couros, 2014; Hero, Lindfors, & Taatila, 2017; Moesta, 2022; National Innovation Agency, 2019; The Office of the Basic Education Commission, 2019; Kothana, 2020; Thailand Productivity Institute, 2020; Chamchoi, 2022; National Innovation Agency, 2023; Phothong, 2023)

Step 2: Examine the consistency of the component model and indicators of primary school teacher innovator with empirical data.

Examine and confirm the composition and indicators of innovators among primary school teachers under the Office of the Basic Education Commission in the Northeastern Region. From the study, analysis, and synthesis of related documents and research, it was found that there are 5 elements: 1) initiative, 2) observation and questioning, 3) interaction with others, 4) application, and 5) adapting to the situation.

3.2 Population, Sample Group, and Data Sources

1) The population includes primary schools under the Office of the Basic Education Commission in the Northeast in the year 2023 from 12,088 schools (Office of the Basic Education Commission, 2023).

2) The sample group in the confirmatory factor analysis (CFA) included 220primary school teachers under the Office of the Basic Education Commission in the Northeast Region for the year .2023The researcher determined the sample size using the criteria of Hair et al. (2010) according to Hair et al. (2010) suggested that confirmatory factor analysis (CFA) should collect a sample of at least 200 people. Tabachnick and Fidell (2017) recommended that the sample size be appropriate to the size of the model, with a sample size of 200 or more being suitable for a medium-sized model. Schumacker and Lomax (2010) stated that the sample size should be 20 times the number of observed variables. In this study, there are 11 observed variables, so using a ratio of 20:1, the sample size should be 220 people. Thus, the sample size based on the number of variables studied is 220 individuals, consisting of

primary school teachers under the Office of the Basic Education Commission in the Northeastern region. The study found that there were 11parameters. Therefore, the sample size of primary school teachers was 220people and used a multi-stage random sampling.

4. Research Framework

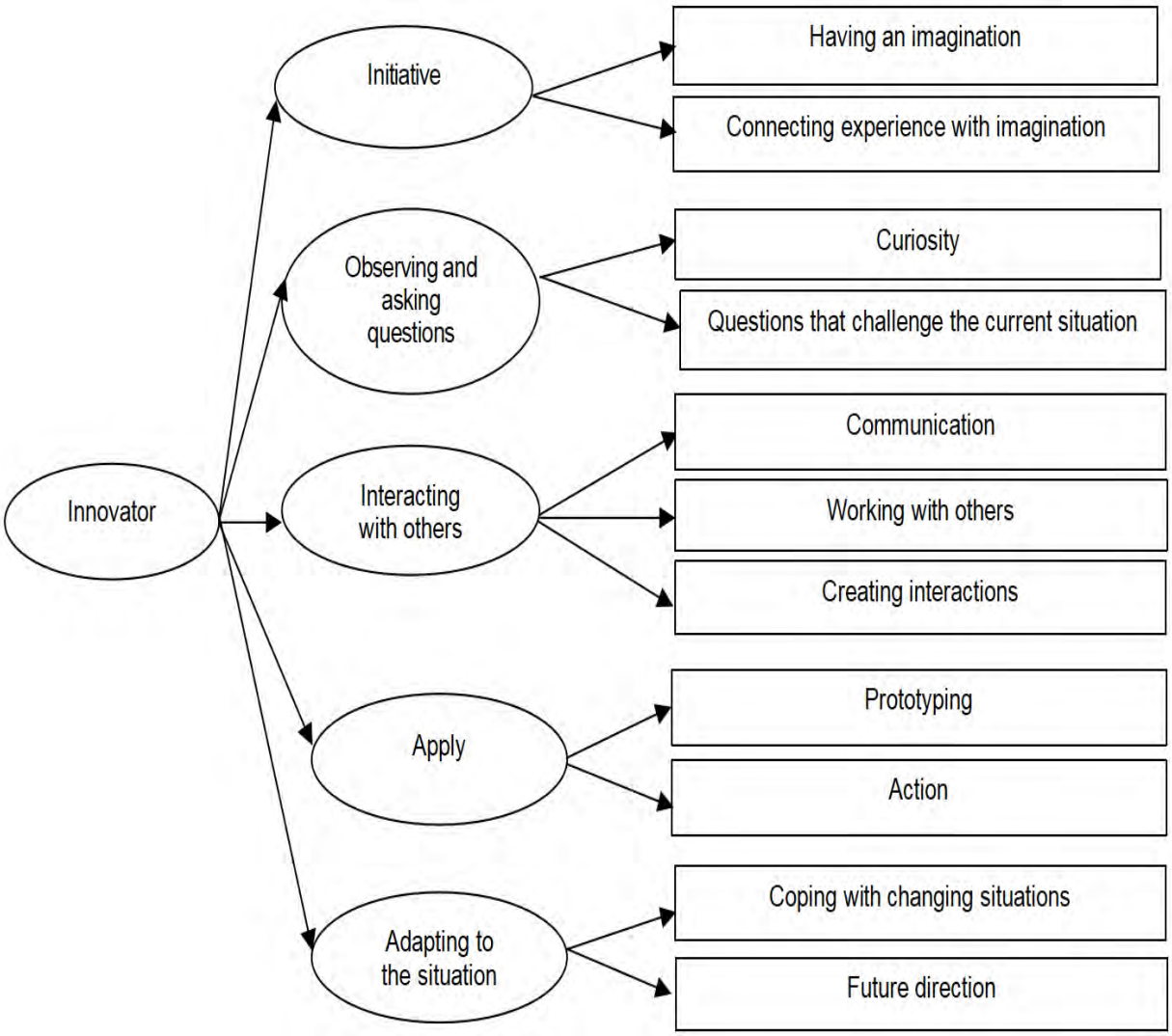

Figure 1. Conceptual framework

5. Method

This study is a construct validity analysis to examine the theoretical relationship between the five components, divided into 2 steps, as detailed below.

Step 1: Study of the components and Indicators of Innovator in Primary School Teachers under the Office of the Basic Education Commission in the Northeastern Region.

1) The Research sources

The researcher studied documents, textbooks, books, articles, and research related to the components and indicators of innovator in primary school teachers.

2) Tools and Research Instrument Development

The tools used in this research were a document synthesis record form and related research.

3) Data Collection

The researcher studied relevant documents and research both domestically and abroad to synthesize information on the components of innovator in primary school teachers.

4) Data Analysis

The researcher summarized the components and indicators of innovators in primary school teachers by analyzing content data from documents, textbooks, books, articles, and related research using descriptive statistics and frequency distribution.

Step 2: Examine the consistency of the components and indicators model of innovators in primary school teacher with empirical data.

1) Research Population

The population includes primary school teachers under the Office of the Basic Education Commission in the Northeast for the year 2023, encompassing 20 provinces, 61 primary education areas, and 12,088 schools (Office of the Basic Education Commission, 2023).

2) The Research Participant

Sample groups include primary school teachers under the Office of the Basic Education Commission in the Northeast for the year 2023. This phase of research is a confirmatory factor analysis. The sample size of Hair et al. (2010) suggests that it must not be less than 100 samples and that the ratio of the number of samples to the number of parameters to be estimated is 10–20 samples per parameter. For this research, 11 parameters are used with a ratio of 20:1. Therefore, the sample size, derived from the number of variables obtained from the study, is 220 people. This includes primary school teachers under the Office of the Basic Education Commission in the Northeast, obtained through 4 stages of multi-stage random sampling.

3) Tools and Research Instrument Development

The instrument used in this research was a questionnaire to develop components and indicators of innovator in primary school teachers, which the researcher developed and consisted of 2 parts: Part 1 is the basic information of the respondents using a checklist to survey the basic information of the respondents, totaling 6 questions. Part 2 includes 50 five-point Likert scale questions about the elements and indicators of innovators among primary school teachers. The questionnaire developed by the researcher was checked for content validity using an index of consistency (IOC) between questions and the term definitions. From the 50 questions, it was found that the consistency value (IOC) ranged between 0.80 and 1.00, with the overall version equal to 0.98. The questionnaires were then trialed with 50 primary school teachers who were not in the sample, and the results were analyzed using Pearson Product Moment Correlation to assess the correlation between individual question scores and the total score. It was found that there was discriminatory power for each item, with item discrimination indices ranging between 0.24 and 0.83, and the reliability Cronbach's alpha coefficient (α) was 0.97.

4) Data Collection

Upon receiving approval from the Human Research Ethics Committee, the researcher distributed the questionnaire and a letter requesting cooperation from the sample group through the Faculty of Education, Mahasarakham University. The letter explained the purpose and related details of the study and requested permission to use the questionnaires for data collection. Data were collected via Google Forms from a total sample of 220 participants, accounting for 100 percent of the sample.

5) Data Analysis

The researcher analyzed the data using confirmatory factor analysis (CFA). By examining the harmony of the model between the number of components and the indicators of components weight values, the steps started from specifying the model specification with the first-order confirmatory element measurement model, considering the values of Chi-square: $\chi 2$, Chi-square Statistics: CMIN/df, GFI, AGFI, IFI, CFI, TLI, RMSEA to assess the appropriateness of the overall measurement model through the AMOS program.

6. Results

The researcher divided the analysis of the data into two parts according to the objectives as follows:

Step 1: Study of the components and indicators of innovator in primary school teachers under the Office of the Basic Education Commission in the Northeastern Region.

Results of data analysis from a synthesis of documents, textbooks, academic articles, research reports both domestically and internationally using content analysis. There was a total of 5 components and 11 indicators as shown in Table 1.

Table 1. Components and indicators of innovator in teacher

5 components	11 indicators
1. initiative	1) Having an imagination
	2) Connecting experience with imagination
2. Observing and asking questions	1) Curiosity
	2) Questions that challenge the current situation
3. Interacting with others	1) Communication
	2) Working with others
	3) Creating interactions
4. Apply	1) Prototyping
	2) Action
5. Adapting to the situation	1) Future direction
	2) Coping with changing situations

Step 2: Checking the consistency of the components and indicators model of innovator in primary school teachers with empirical data.

1) The results of the analysis of the five components and indicators of innovator of primary school teachers had a statistically significant weight of the components determined from the chi-square value ($\chi 2$) equal to 15.073 degrees of freedom (df) is equal to 22, the Relative Chi-Square value ($\chi 2$/df) was equal to 0.685, the statistical significance (p-value) is equal to 0.859, the Goodness of Fit Index: GFI (GFI) was equal to 0.988, the harmonization index is Adjusted Goodness of Fit Index (AGFI) was equal to 0.964, Incremental Fit Index (IFI) was equal to 1.007, Tucker Lewis index (TLI) was equal to 1.018, Comparative Fit Index (CFI) was equal to 1.000. Normed Fit Index (NFI) was equal to 0.985, Root Mean Squared Residuals (RMR) was equal to 0.004, Root Mean Square Error of Approximation (RMSEA) was equal to 0.000. It showed that all 5 components and indicators of innovator of primary school teachers were indicators of innovation with statistical significance. This meant that the developed model of components and indicators of innovator of primary school teachers was consistent with the empirical data. The model of components and indicators of innovator of primary school teachers can be shown as in Table 2.

Table 2. Results of the second confirmatory factor analysis of aggregate indicator of primary school teachers' innovator in all five components

Variable	Indicators	Factor Loading	R^2	Error (e)
Component	1: Initiative (Initi)	.920	.846	.846
I1	1.1 Imagination	.734	.538	.538
I2	1.2 Connecting experience with imagination	.690	.476	.476
Component	2: Observing and asking questions (Obser)	.962	.926	.926
O1	2.1 curiosity	.668	.446	.668
O2	2.2 Questions that challenge the current situation	.737	.544	.737
Component	3: Interacting with others (Inter)	.983	.967	.967
N1	3.1 communication	.671	.450	.671
N2	3.2 Working with others	.516	.266	.516
N3	3.3 Interaction	.634	.401	.634
Component	4: Applying (Appy)	.939	.881	.881
A1	4.1 Prototyping	.737	.544	.737
A2	4.2 Action	.805	.649	.805
Component	5: Adapting to the situation (Adap)	.987	.974	.974
D1	5.1 Future direction	.545	.297	.545
D2	5.2 Coping with changing situations	.691	.477	.691
Results: $\chi 2 = 15.073$, df = 22, $\chi 2/df = 0.685$, P-value = 0.859, GFI = 0.988, AGFI = 0.964, NFI = 0.985, TLI =1.018, IFI = 1.007, CFI = 1.000, RMSEA = 0.000, RMR = 0.004.				

The factor loadings of every component indicator had a positive value ranging from 0.920 – 0.987 and had a statistical significance level of .05, indicating that all 5 components of the 11 indicators were factors that affect innovator of primary school teachers. When considering the weight of each components and indicators, it was found that adapting to situations had the highest weight of 0.987, followed by interaction with others with a weight of 0.983. Observation and asking questions had a weight of 0.983. equal to 0.962, implementation had a weight of 0.939 and initiative had a weight value of 0.920, respectively. The prediction coefficient (R^2) was between 0.846–0.974 when considering the elements that affected the innovator of elementary school teachers. Ranked from highest to lowest weight were adaptability, followed by interaction with others, observation and questioning, application, and initiative. It showed that all 5 components and 11 indicators can be used to measure innovators and confirm the innovator model of primary school teachers according to the theoretical framework as defined by the researcher, as shown in Figure 2.

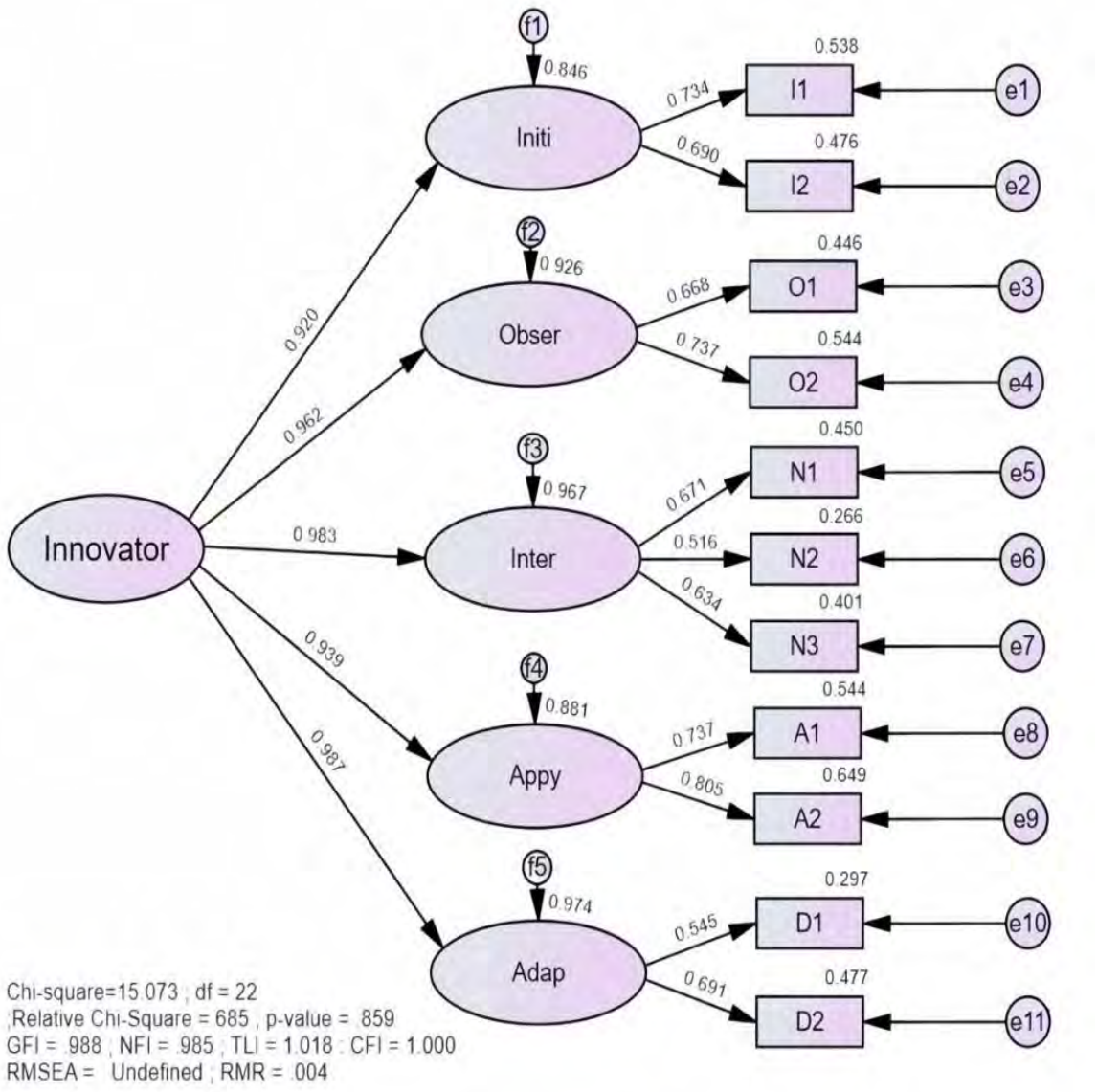

Figure 2. Second confirmatory factor analysis model of primary school teachers' innovation

Note. Initi: Innitative; Obser: Observing and asking questions; Inter: Interacting with others; Appy: Apply; Adap: Adapting to the situation. $\chi 2$= 15.073, P-value = 0.859, CFI =1.000, RMSEA = 0.000.

The result of the second confirmatory factor analysis on the inovator of primary school teachers that consistent with the empirical data ($\chi 2 = 15.073$, P-value = 0.859, CFI =1.000, RMSEA = 0.000) was found that there were 5 elements include Adapting to the situation (Adap), Interacting with others (Inter), Observing and asking questions (Obser), Apply (Appy), Initiative (Initi), respectively.

7. Discussion

A study of the components and indicators of innovators in primary school teachers found that innovators are individuals who generate creative ideas to produce new things, develop new methods, processes, tools, and formats that create value, provide convenience, and solve everyday problems or enhance work efficiency. In education, diversity among innovators is crucial because they significantly drive progress in various domains: 1) Economically, innovators create innovations, products, and services that enhance economic value, improve work efficiency, and create commercial opportunities. 2) Socially, innovators devise new solutions to complex social issues, leveraging technology and innovation to enhance quality of life. 3) Scientifically and technologically, they drive new scientific discoveries and develop technologies to improve efficiency. 4) Educationally, improving the education system involves innovating teaching techniques, learning aids, and updating curricula to respond to societal changes. Many nations are currently navigating disruptive digital transitions, contributing to a volatile, uncertain, complex, and ambiguous (VUCA) global environment. The 2019 coronavirus pandemic accelerated transformations worldwide, impacting economies, societies, and educational paradigms to prepare human resources for the future. Consequently, education is designed to equip students with the skills to navigate global developments. Therefore, teachers must themselves be innovators to impart knowledge and instill innovative abilities in their students. The study identified five essential components and eleven indicators for innovator skills: 1) taking initiative, 2) observing and asking questions, 3) interacting with others, 4) applying knowledge, and 5) adapting to situations, consistent with Klaichan's research (2020). Strengthening innovators involves four elements: 1) academic administration, 2) design thinking processes, 3) innovation creation concepts, and 4) skills to foster and discover creativity, including connection, questioning, observation, experimentation, and networking skills. Chalarak (2021) summarized ten elements defining innovator teachers: 1) willingness to experiment and take proactive actions, 2) integration skills to perceive relationships between elements, 3) imagination, initiative, and creativity, 4) effective networking and communication skills, 5) flexibility and a pursuit of new knowledge and concepts, 6) linking curriculum with digitalization, 7) observation and inquiry skills, 8) integration of knowledge, experiences, ideas, and technology into local contexts, 9) problem-solving abilities, and 10) calmness under pressure. These elements align with Atmojo et al. (2019). Developing innovator and entrepreneurial skills in elementary school teachers necessitates: 1) making connections, 2) posing questions, 3) observing and making inferences, 4) designing experiments, and 5) networking. Hero & Lindfors (2019) explored multidisciplinary innovation projects impacting innovator skills: 1) personal skills such as uncertainty tolerance, flexibility, initiative, responsibility, and leadership; 2) teamwork including promotion, coaching, task allocation, social skills, and collaboration; 3) network creation, communication, and planning encompassing creativity, strategic planning, and commercialization; and 4) invention and research skills covering ideation, prototyping, testing, marketing, sales, and entrepreneurship.

Examination of the consistency of the model of components and indicators of innovators in primary school teachers with empirical data under the Office of the Basic Education Commission reveals that there are 5 components and 11 indicators. All 5 components and 11 indicators have weight values above 0.3, indicating good agreement with empirical data, ranging from 0.920 to 0.987. When considering the weight values for each component, the adaptability component had the highest weight of 0.987, followed by the interaction with others component at 0.983. The observation and questioning components scored 0.962, the application component 0.939, and the initiative component 0.920, respectively. The components and indicators in each area demonstrate a relatively high positive relationship. From the data in Table 2, it is possible to formulate a model for the innovator indicators of primary school teachers under the Office of the Basic Education Commission. The data highlight a strong relationship between adapting to situations and interacting with others, with adaptability appearing as the most prominent factor among individuals with innovative skills. To become an innovator, an individual must exhibit behaviors characteristic of initiators or inventors, demonstrating creative thinking in producing new things. Factor analysis underscores the talents needed for primary school teachers to be innovators when designing indicators based on relevant concepts, theories, and research. This framework is reliable and can be used for indicators of teacher innovation, consistent with Pupat et al. (2018), who argue that developing indicators based on concepts and theory involves selecting variables that are interrelated, prioritizing important variables, and minimizing less significant ones. This process clarifies variable meanings and allows for precise definitions, aiding in determining which factors to examine and how they are interconnected. Creating theoretical indicators is thus one of the most

reliable approaches, according to Phusri (2021), who studied teachers' innovator models, finding consistency with empirical data for all 5 components, each positively related: 1) initiative skills, 2) questioning skills, 3) observation skills, 4) experimentation skills, and 5) network building skills. Similarly, Grover and Chawla (2020) investigated discovery skills and inventive work behavior, identifying six aspects of innovators: 1) linking ideas, 2) experimenting, 3) networking, 4) observing, 5) asking questions, and 6) disregarding requirements. Their research revealed interconnectedness among these factors. Individuals with discovery abilities develop ideas and enhance awareness, translating them into practical ideas and creative work habits, thereby fostering high inventiveness. Similar to Engel et al. (2015) explored the characteristics of outstanding innovators, identifying six key traits: understanding goals for achieving success, perceiving directions uniquely, identifying desired innovations, managing production and responding to needs, understanding personal capabilities and developmental objectives, and clearly mapping innovation. Sorting the weight values of elements influencing innovators from highest to lowest aligns with Chamchoi's (2020) study on innovator competencies through confirmatory factor analysis, showing consistency with empirical data across six components: future orientation, creativity, social networks, project management, content knowledge and practical skills, and personal personality. This model assesses innovator competency, aligning with the 21st-century traits of Thai children (3R8Cs) and educational outcomes highlighted by Hero, Lindfor and Taatila (2017), who identified six success factors for innovators: future direction, social skills, creative skills, project management skills, content knowledge, and personal personality. These skills influence the process of developing teaching innovations and evaluating individual abilities. Therefore, confirmatory factor analysis (CFA) is the most suitable method for examining the construct validity of primary school teachers' innovator.

8. Recommendation

8.1 Recommendation Applied from the Research

1) The results of the research found that the change situation components had higher weight values than all aspects. Therefore, it is necessary to develop teachers and educational personnel so that teachers can predict or evaluate future directions that may occur, understand changing situations, and accept adaptation to the future as the first priority in order for teachers to develop and becoming an innovator effectively.

2) The results of the research found that the components and indicators model of innovator in primary school teachers under the Office of the Basic Education Commission harmonized with empirical data, therefore, educational agencies at all relevant levels can take the components and indicators of innovator in primary school teachers, which can be used as goals or ways to develop innovativeness of primary school teachers to have more of these 5 components.

3) Primary school agencies should create awareness so that teachers see the importance of developing teachers as innovators and encourage teachers to be committed and determined in developing new innovations, new ideas, new methods, new process, new tools, including new formats, to develop work or develop students to be effective.

8.2 Recommendation for Future Research

1) The further research should be conducted on the development of a program to enhance the innovativeness of primary school teachers under the Office of the Basic Education Commission.

2) There should be research on the innovator development model of digital teachers in primary schools under the Office of the Basic Education Commission.

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Authors' contributions

Supangjit Kanlayakaew was responsible for designing the study and drafting the manuscript, while Dr. Pacharawit Chansirisira was responsible for reviewing the research methodology and data to ensure completeness and accuracy, and Dr. Suwat Julsuwan was responsible for reviewing the statistical data used in the research.

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Informed consent

Obtained.

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The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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