



Factor analysis of Thai students' innovator and entrepreneur competency

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Abstract

Student outcomes are the goal of education. In a rapidly changing world, students must equip innovator and entrepreneur competencies. This study aimed to develop and validate students' innovator and entrepreneur competencies through exploratory (EFA) and confirmatory factor analysis (CFA). Data were gathered through a questionnaire from a sample of 2,008 students from 80 different-sized schools. Results of EFA revealed that nine factors and 49 indicators were explored, with factor loadings ranging from .504 to .985. The nine factors included: (1) questioning; (2) apophenia; (3) pursuing multiple streams; (4) observing; (5) obsessive notetaking; (6) experimenting; (7) idea networking; (8) innovative entrepreneurial leadership; and (9) social, environmental, and economic responsibility and sustainability (SEERS). CFA results showed an acceptable fit of the 9-factor model with fit indices: $\chi^2 = 3,372.623$, $df = 1091$, $p = .000$, $\chi^2/df = 3.091$, CFI = .919, TLI = .913, RMSEA = .046, and SRMR = .044. Implications and further research were discussed.

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Introduction

Thailand has made efforts to cope with future changes by initiating the Thailand 4.0 policy under the philosophy of sufficiency economy in the first agenda to prepare Thai people 4.0. This policy is preparing new seeds by cultivating Thai people to be complete human beings in the 21st century, along with the development of Thai people 4.0. In addition, the 2018 National Education Standards enable learners to develop themselves as “learners, active citizens, and innovative co-creators” to

develop innovations in society, increase opportunities and value for self and society, as well as having cross-disciplinary integration capabilities and entrepreneurial qualities (Office of the Education Council [ONEC], 2019). Therefore, developing learners to have innovator and entrepreneur competencies (IEC) ensures the quality of human resources in the country and prepares the workforce as a key engine in driving economic growth.

Previous studies focused on innovator and entrepreneur competencies separately. Literature suggests disruptive skills of innovators (Dyer et al., 2019), traits of great innovative entrepreneurs (Nguyen, 2015), and new entrepreneurial leaders (Greenberg et al., 2011) that are not confirmed by the statistical approach to creating construct validity. This study argues that innovators and

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entrepreneurs are interdependent, and thus the current study aims to develop and validate the construct of innovator and entrepreneur competency. The current study is significant for educators to measure students with valid dimensions of the innovator and entrepreneur competency confirmed by this study.

Literature Review

As stated in the introduction, the literature review is not exhaustive. It focuses on three concepts: disruptive skills of innovators, innovative entrepreneurs, and new entrepreneurial leadership.

Innovators

Several scholars and researchers suggest an innovator's skills. However, popular and breakthrough evidence is derived from a work called "The Innovator's DNA" by Dyer et al. (2019). They conducted six years of research and found that disruptive innovators possessed five discovery skills: associating, questioning, observing, experimenting, and idea networking. Associating is the ability to think differently from others and solve challenging problems creatively by connecting diverse ideas, knowledge, and experiences to innovate new things with enthusiasm in continuous learning on new trends. Questioning is the ability to ask questions that challenge the status quo or conventional work, which benefits creativity and discovery on the unprecedented by questioning yourself or others imaginatively, such as "why... and why not..." in order to gain an understanding or important idea and "What if..." to speculate on the question in a new perspective. Observing is the ability to carefully observe the people involved and things in daily life with the five senses and take notes to look for opportunities for innovation. Experimenting is the ability to examine or experiment to creatively find solutions to problems, analyze the design process to understand the surroundings, find new experiences, and predict future possibilities. Finally, idea networking is the ability to collaborate or interact with different people in various contexts to design and experiment with innovations.

Innovative Entrepreneurs and Entrepreneurial Leadership

In this modern era, innovators and entrepreneurs are theoretically interdependent and cannot be distinguished. The innovators need entrepreneurial skills to bring innovations into the markets, while the entrepreneurs

need innovations for competitive advantages. To this end, the concept of innovative entrepreneurs emerges.

Innovative entrepreneurs possess ten traits—apophenia, being innovative, obsessive notetakers, preaching perfection but practicing progress, being allied with their fear, not waiting for things to break, understanding the creative process, pursuing multiple streams, possessing a healthy arrogance, and embracing paradoxical thinking (Nguyen, 2015).

In a book entitled "The New Entrepreneurial Leader: Developing Leaders Who Shape Social and Economic Opportunity" by Greenberg et al. (2011), they found three competencies for entrepreneurial leaders for social and economic opportunity: (1) cognitive ambidexterity; (2) social, environmental, and economic responsibility and sustainability (SEERS); and (3) self- and social awareness (SSA).

Thai Students' Innovator and Entrepreneur Competency

The three mentioned concepts including innovators, innovative entrepreneurs, and new entrepreneurial leaders build a conceptual framework for IEC. However, the concepts are generally at the adult level. In education, the main goal is students' learning outcomes. To develop students' IEC as a learning outcome, it is essential for educators to have a clear and valid framework for the students' IEC. In the meantime, previous literature does not combine innovator and entrepreneur concepts into a single construct. Therefore, there are no empirical data to confirm such. Confirming the conceptual framework therefore is the first step to go in developing students' IEC. In addition, the reason why this study puts Thai students in the agenda is to make the study more localized.

Methodology

Scale Development

The researcher reviewed relevant literature (Dyer et al., 2019; Greenberg et al., 2011; Nguyen, 2015) and summarized it into 18 subscales with operational definitions. Based on the operational definitions and sources from the literature, the researcher revised and developed items of each subscale according to student respondents, and the items ranged from five to six items per subscale, as shown in Table 1. The number of at least three items per variable is recommended. An initial pool of 92 items was established. The 92-items were rated with the five-point Likert scale (from 1 = strongly disagree to 5 = strongly agree). All items were positively worded.

Table 1 Operational definitions, items, and reliability of innovator and entrepreneur competency scale and subscales

Scale and Subscales	Operational Definitions	Items (count)	α
Innovator and entrepreneur competency	The components of skills and competencies that enable students to become innovators and entrepreneurs in the future or when they complete their education based on the three concepts: innovators, innovative entrepreneurs, and entrepreneurial leaders.	-	-
Associating	the ability to think differently from others and solve challenging problems creatively by connecting diverse ideas, knowledge, and experiences to innovate new things with enthusiasm in continuous learning on new trends.	5	.609
Questioning	the ability to ask questions that challenge the status quo or conventional work, which benefits creativity and discovery on the unprecedented by questioning yourself or others imaginatively, such as “why...” and “why not...” in order to gain an understanding or important idea and “What if...” to speculate on the question in a new perspective.	5	.573
Observing	the ability to carefully observe the people involved and things in daily life with the five senses and take notes to look for opportunities for innovation.	5	.791
Experimenting	the ability to examine or experiment to creatively find solutions to problems, analyze the design process to understand the surroundings, find new experiences, and predict future possibilities.	5	.770
Idea networking	Idea networking is the ability to collaborate or interact with different groups of people in a variety of contexts to design and experiment innovations.	5	.792
Apophenia	The ability to see models or patterns in meaningful connections in uncorrelated objects or information.	5	.735
Being innovative	The ability to find the best and easiest ways to create the best results.	5	.833
Obsessive notetakers	The ability to collect data through a note-taking method for work productivity and innovation.	5	.841
Preaching perfection but practicing progress	The ability to set high-expected goals and reach goals at intervals like a long dream to reach.	5	.690
Being allied with their fear	The ability to turn fear into friendliness like turning crisis into opportunity, turning fear into effort for progress and innovation.	5	.782
Not waiting for things to break	The ability to pioneer and improve work (e.g., It can always be better) without waiting for the problem to exist to ensure the problem will never even exist and to take preventive action.	5	.789
Understanding the creative process	The ability to work according to the creative process: preparation, incubation, illumination, and implementation.	5	.799
Pursuing multiple streams	The ability to search for alternatives or multiple results.	5	.842
Possessing a healthy arrogance	Being high-level confident in one's ability to work towards goals.	5	.799
Embracing paradoxical thinking	The ability to take advantage of contradictory concepts.	5	.682
Cognitive ambidexterity	The ability to think, that combines predictive thinking with creative thinking for entrepreneurship.	5	.863
SEERS	Entrepreneurship that considers the impact on the society, environment, and economy rather than the pursuit of maximum profit.	6	.828
SSA	An empathetic perception of what is happening within oneself and society, accepting diversity and respecting others.	6	.820

Participants

The minimum response rate was a ratio of 5:1 (observations per variable) and a ratio of 10:1 is recommended for factor analysis (Hair et al., 2019). The data set of 2,008 Thai secondary students from 80 different-sized schools was randomly and equally split into two similar datasets in nature. Student samples of 1019 and 989 were used in EFA and CFA, respectively. Table 2 provides the demographic details of the respondents.

Data Collection

Prior to data collection, the researcher obtained the research ethical approval from the Institutional Research Board (IRB) of a large university in Thailand. Data were gathered through a survey questionnaire in an online protocol (SurveyMonkey). Student participants were informed about research ethics by reading them on the first page before filling out the next sections; their participation was voluntary and confidential. Completing and submitting the questionnaires were deemed participation in this study.

Data Analysis

Data were analyzed using factor analysis. Exploratory factor analysis (EFA) was used to reduce items using Statistical Package for the Social Sciences (SPSS) Version 28. Principal component analysis (PCA) was chosen for factor extraction. PCA is recommended when dimension reduction is a primary objective (Hair et al.,

2019). “While principal components with varimax rotation and the Kaiser criterion are the norm, they are not optimal, particularly when data do not meet assumptions, as is often the case in the social sciences” (Costello & Osborne, 2005). This study utilized the promax oblique rotation method to simplify the factor structure and loadings. Items with single-factor loadings of less than 0.5 and cross-loadings of 0.3 or greater were eliminated. According to Hair and his colleagues, factor loadings of 0.3 or greater can be significant. Confirmatory factor analysis (CFA) was employed for validating the factor structure obtained from EFA results using Mplus 8.

Results

Exploratory Factor Analysis

The Kaiser–Meyer–Olkin index of sampling adequacy (KMO = .979) suggested that the sample was appropriate for factor analysis, and significant Bartlett’s test of sphericity ($\chi^2 = 59,983.434$, $df = 4,186$, $p < .001$) indicated that correlation matrix was not identity matrix, meaning that observed variables (or items) were correlated. Thus, the data were appropriate for factor analysis. Results of EFA suggested eleven factors to be extracted upon eigenvalues greater than 1. The 11 factors explained 58.62 percent of the variance. Based on cut-off criteria mentioned in the methodology section, 43 items were removed. As a result, a 9-factor solution consisting of 49 items was chosen because it was conceptually interpretable (see details in Table 3).

Table 2 Demographic information of the student sample

Variables	EFA Sample		CFA Sample	
	Frequency	Percent	Frequency	Percent
Gender				
Male	264	25.91	258	26.09
Female	755	70.09	731	73.91
Total	1,019	100	989	100
School Affiliation				
Department of Education Bangkok	26	2.55	23	2.30
Primary Educational Service Area Office	4	0.39	3	0.30
Secondary Educational Service Area Office	950	93.23	924	93.40
Office of the Private Education Commission (OPEC)	14	1.37	17	1.70
Local government	25	2.45	23	2.30
Total	1,019	100	989	100
Grade Level				
Grade 9	497	48.77	514	52.07
Grade 12	522	51.23	475	47.93
Total	1,019	100	989	100

Table 3 Factor loadings of EFA ($n = 1,019$) and first- and second-order CFA ($n = 989$)

Factors/Items	Factor Loadings	
	EFA	CFA
Factor 1: Questioning (Ques)		0.613
Item 1. Frequently, my ideas or perspectives diverge radically from others' perspectives. (ques1)	0.838	0.496
Item 3. I can relate the different concepts and ideas that appear at first glance. (ques2)	0.562	0.657
Item 8. I ask more questions than others. (ques3)	0.717	0.532
Factor 2: Apophenia (Apop)		0.656
Item 26. I am able to create innovations from a combination of data from multiple sources. (apop1)	0.584	0.704
Item 27. I can see the possibility of linking potentially inconsistent data. (apop2)	0.713	0.709
Item 30. I often experiment with connecting unrelated information to create new ideas. (apop4)	0.697	0.691
Item 71. I am able to mix different methods as the best method. (apop5)	0.570	0.732
Factor 3: Pursuing multiple streams (Pursue)		0.554
Item 59. I create something that helps to capture or express other people's thoughts. (pursue1)	0.536	0.646
Item 61. I am eager to find ways to innovate. (pursue2)	0.571	0.753
Item 62. I take action and seize new opportunities to innovate even in unfavorable circumstances. (pursue3)	0.632	0.762
Item 63. I bring my innovations to new contexts. (pursue4)	0.692	0.739
Item 64. I turn a crisis into an opportunity to start innovation. (pursue5)	0.650	0.796
Item 65. I tend to innovate before there is a need for innovation or forced by an event. (pursue6)	0.638	0.703
Factor 4: Observing (Observ)		0.853
Item 11. I often come up with new ideas when I am observing people's interactions with products and services. (observ1)	0.504	0.720
Item 12. I am always observing the behaviors and activities of my clients and related organizations to come up with new ideas. (observ2)	0.621	0.769
Item 13. I observe how each person uses their products and services to help me get new ideas. (observ3)	0.617	0.734
Item 14. I create new ideas by observing things around the world. (observ4)	0.525	0.669
Factor 5: Obsessive notetaker (Note)		0.707
Item 36. I habitually take notes of new ideas that arise in my daily life. (note1)	0.693	0.682
Item 37. I have the ability to record things exactly as they are. (note2)	0.797	0.796
Item 38. When I take notes, I record the information consistent with the others. (note3)	0.799	0.698
Item 39. I am able to accurately note the details of things. (note4)	0.869	0.801
Item 40. I can use the note-taking method to collect data as detailed as any other method. (note5)	0.903	0.751
Factor 6: Experimenting (Exper)		0.600
Item 17. I am always testing and experimenting or piloting new ways of working. (exper1)	0.574	0.770
Item 18. I experiment to understand how things work. (exper2)	0.661	0.792
Item 19. I search for new ideas through experimentation. (exper3)	0.622	0.722
Factor 7: Networking (Net)		0.675
Item 21. I talk to different groups of people from different and diverse contexts to find and refine new ideas. (net1)	0.605	0.750
Item 22. I go to meetings with new people on the same project or business event and beyond to learn about the issues they face. (net2)	0.619	0.722
Item 23. I create a network of people to refine my new perspectives and ideas. (net3)	0.583	0.770
Factor 8: Innovative Entrepreneurial Leadership (Entre)		0.460
Item 49. I always overcome my fear and move forward. (entre1)	0.626	0.702
Item 50. I am willing to try something I don't know. (entre2)	0.725	0.698
Item 54. I always reevaluate my experiences so that I can learn and improve next time. (entre3)	0.509	0.696
Item 66. I always encourage myself when faced with challenging situations. (entre4)	0.859	0.772
Item 67. When I am in a critical situation, I believe that it will always pass. (entre5)	0.985	0.790
Item 68. I am always looking for ways to overcome obstacles on my own. (entre6)	0.829	0.777
Item 69. Even though people around me think that obstacles are difficult, I am always confident that I can get through them. (entre7)	0.867	0.794

Table 3 Continued

Factors/Items	Factor Loadings	
	EFA	CFA
Item 70. I am ready to act even though I think I may not be ready. (entre8)	0.771	0.719
Item 87. I easily find things that make me happy. (entre9)	0.704	0.643
Item 88. I can overcome challenges by believing in myself. (entre10)	0.872	0.777
Item 89. I believe in my skills and accept my imperfections. (entre11)	0.883	0.753
Item 90. I easily complete any task or activity with others because I understand the diversity of colleagues. (entre12)	0.602	0.723
Item 91. I am confident in my ability to successfully collaborate with others. (entre13)	0.661	0.762
Item 92. I listen to my colleagues' opinions rationally on the basis of individual differences. (entre14)	0.711	0.776
Factor 9: SEERS		0.536
Item 81. I do things that benefit society more than I do for myself. (seers1)	0.791	0.718
Item 82. I share the benefits of work or activities with society. (seers2)	0.703	0.751
Item 83. I have always been mindful of the impact that action will have on the economy. (seers3)	0.741	0.775
Item 84. I participate in activities that promote sustainable economic development. (seers4)	0.811	0.742
Item 85. I focus on creating work that values the environment. (seers5)	0.765	0.818
Item 86. I use environmental-friendly products and services. (seers6)	0.702	0.725

Note: Numbers in Bold are standardized factor loadings of latent variables in second-order CFA.

$p < .001$.

Confirmatory Factor Analysis

The Kaiser–Meyer–Olkin index of sampling adequacy (KMO = .970) and significant Bartlett's test of sphericity ($\chi^2 = 29,450.884$, $df = 1,176$, $p < .001$) indicated that the sample was appropriate for factor analysis. The second-order CFA was used to ensure that multiple latent variables measured the construct of innovative and entrepreneur competency. Goodness-of-fit indices were used for model fit evaluation: χ^2 test, degree of freedom (df), χ^2/df , Comparative fit index (CFI), Tucker–Lewis index (TLI), Root mean square error of approximation (RMSEA), and Standardized Root Mean Squared Residual (SRMR). Good model fit criteria included significant χ^2 test, CFI and TLI greater than .92, and RMSEA and SRMR less than .008 (Hair et al., 2019). Second-order CFA results of the 9-factor solution from the EFA study revealed good model fit to the data with fit indices: $\chi^2 = 3,210.829$, $df = 1110$, $p = .000$, $\chi^2/df = 2.893$, CFI = .926, TLI = .921, RMSEA = .044, and SRMR = .049. This complete model with standardized factor loadings is illustrated in Figure 1. All items were loaded greater than .5 except for item “Ques1” with the value of .496, and most items were equal to or greater than .7 (see details in Table 3). Items with standardized factor loadings of .5 or greater and .7 or greater are considered acceptable and good, respectively, according to Hair et al. (2019).

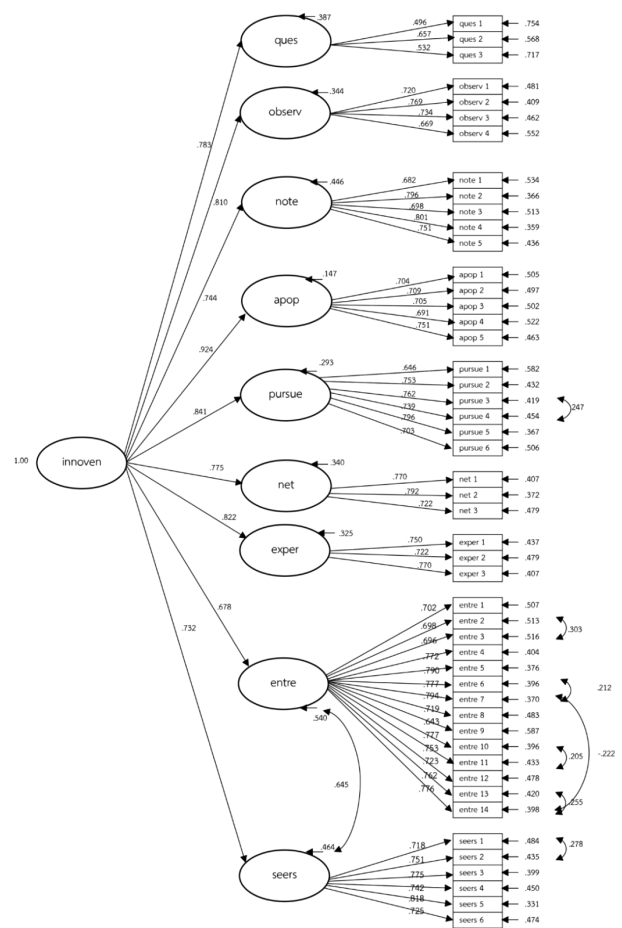


Figure 1 Second-order CFA results for IEC scale $\chi^2 = 3,210.829$, $df = 1110$, $p = .000$, $\chi^2/df = 2.893$, CFI = .926, TLI = .921, RMSEA = .044, and SRMR = .049.

Table 4 provides factor correlations between the nine factors measuring innovator and entrepreneur competency of the students. All measures were positively correlated, and the correlations were between .344 and .744. Most standardized factor loadings were close to and even greater than .7 (see Table 3). Values of Average Variance Extracted (AVE) were between 0.320 and 0.581, which were greater than 0.5 except for variable “Ques” (AVE = 0.320). Composite and Cronbach’s Alpha reliabilities of all variables were above .7 except for variable “Ques” (CR = 0.582 and α = .576); however, they were close to .6. Thus, convergent validity was acceptably met. Regarding discriminant validity, AVE should be greater than Maximum Shared Variance (MSV) and more than Average Shared Variance (ASV), and square root of AVE should be greater than inter-construct correlation. It is observed that MSV and ASV are in the range of 0.259–0.554 and 0.185–0.345, respectively. Thus, there is no discriminant validity issue.

Discussion

In the EFA, 43 items were removed because they were critical in some ways. Some possible explanations for this result included overlapping meaning and contextual factors. Some items were cross-loaded because some words may have confused the students or made them feel they were the same. Contextual factors may result from items from the literature that do not reflect

high school students in the Thai context. For instance, the five discovery skills of disruptive innovators from the study of Dyer et al. (2019) originally describe real-life successful innovators, not students. Several “Questioning” and “Associating” items were eliminated.

Similarly, in second-order CFA, the retained items of the two above-mentioned latent variables indicated issues. For example, standardized loadings of the three items upon the two variables labeled “Questioning” were below .7, with one item less than .5. Further research will address this issue by revising the three items of “Questioning” in the CFA. Despite higher loadings (equal to or above .7) of most items in the CFA, further studies may need to rethink the items with loadings of less than .7 by revising them into Thai high school students. This study created construct validity by examining convergent validity, construct reliability, and discriminant validity. However, it does not look at concurrent validity that compares the IEC with other similar instruments and predictive validity, that whether the IEC predicts other constructs, such as academic performance, quality of life, and school innovation. Thus, future research should consider this issue.

In this study, most items within the three concepts (i.e., disruptive skills of innovators, innovative entrepreneurs, and new entrepreneurial leadership) remained in the model. This result is consistent with the theoretical framework (Dyer et al., 2019; Greenberg et al., 2011; Nguyen, 2015). It implies Thai high school students perceive themselves having these competencies as hypothesized in this study.

Table 4 Correlation matrix between latent variables, mean, standard deviation, and construct validity and reliability

Latent Variables	Ques	Observ	Note	Apop	Pursue	Net	Exper	Entre	SEERS
Ques	.566								
Observ	.501**	.724							
Note	.424**	.447**	.747						
Apop	.509**	.603**	.609**	.708					
Pursue	.410**	.522**	.587**	.687**	.740				
Net	.444**	.533**	.473**	.562**	.554**	.762			
Exper	.431**	.591**	.485**	.609**	.540**	.544**	.748		
Entre	.349**	.565**	.393**	.542**	.560**	.429**	.510**	.745	
SEERS	.344**	.515**	.483**	.559**	.624**	.459**	.482**	.744**	
<i>M</i>	3.268	3.662	3.237	3.343	3.360	3.345	3.485	3.918	3.686
<i>SD</i>	0.644	0.722	0.783	0.682	0.724	0.822	0.780	0.711	0.724
AVE	0.320	0.524	0.558	0.501	0.548	0.581	0.559	0.555	0.580
MSV	0.259	0.364	0.371	0.472	0.472	0.316	0.371	0.554	0.554
ASV	0.185	0.288	0.243	0.345	0.320	0.252	0.278	0.275	0.289
CR	0.582	0.814	0.863	0.834	0.878	0.806	0.792	0.946	0.892
α	0.576	0.812	0.860	0.835	0.876	0.804	0.792	0.945	0.891

Note: *M* = Mean, *SD* = Standard Deviation, AVE = Average Variance Extracted, MSV = Maximum Shared Variance, ASV = Average Shared Variance, CR = Composite Reliability, α = Cronbach’s Alpha Coefficient. Diagonal elements are square root of AVE.

** $p < .01$.

Conclusion and Recommendation

This study yields a new construct, IEC, that is statistically validated in the sample of high school students. Researchers and practitioners can further use the results with small modifications to some items of “Questioning.” Educators and related practitioners can use the construct of IEC for measuring high school students to identify students’ strengths and weaknesses. Researchers can use the validated construct of the IEC for further analyses with other related constructs.

Conflict of Interest

The author declares that there is no conflict of interest.

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