Creative Problem-Solving Skill Components Of Undergraduate Students

Nipaporn Khamcharoen, Thiyaporn Kantathanawat And Aukkapong Sukkamart
King Mongkut'S Institute Of Technology Ladkrabang, Thailand

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Abstract
The Objective Of This Study Is To Analyze Creative Problem-Solving Skill Components Of Undergraduate Students. The Data Were Collected With Questionnaires. The Samples, 20 Times Of Observation Variables, Were 332 Teachers Of Graduate Users Of 83 Schools In Bangkok By Using Simple Random Sampling. Statistics Used To Analyze Are Frequency, Percentage, Mean, Standard Deviation, And Confirmation Factor Analysis.

The Findings Were Revealed That The Component Model Of Creative Problem-Solving Skill Of Undergraduate Students Was Harmoniousness With Empirical Data That Means The Developed Component Model Can Explain The Component Model Of Creative Problem-Solving Skill Of Undergraduate Students. Therefore, It Can Be Concluded That The Creative Problem-Solving Skill Components Of Undergraduate Students Consist Of 4 Aspects. The Aspect With The Highest Weight Is Flexibility (1.12) Followed By Fluency (0.95), Originality (0.89), And Elaboration (0.87) Respectively.

Keywords: Creative Problem-Solving Skill, Creative Problem-Solving Skill Components, Confirmation Factor Analysis

Introduction

This Study Aims To Study The Creative Problem-Solving Skill Components Of Undergraduate Students. This Is Because Creative Problem-Solving Skills Are Important To Teaching And Learning Management In The 21st Century. Moreover, Creative Problem-Solving Skills Are Basic Skills Which Are Important And Teachers Have To Help Students To Develop As Well As Creative Thinking, Critical Thinking, And Problem Solving Thinking. The Creative Problem-Solving Thinking Skill Consists Of 4 Aspects Which Are 1) Originality Or An Ability To Solve Problems Using New Idea Which Can Solve Problems With Better Efficiency, 2) Fluency Or An Ability To Solve Problems Fast And Efficiently Or An Ability To Find Different Solutions In Limited Time, 3) Flexibility Or An Ability To Solve Varied Kinds Of The Problem By Classifying Groups Of An Idea By Modifying An Idea To Adapt With Different Situations, And 4) Elaboration Or An Ability To See Detail Which Other People Do Not See And To Solve Problems Step By Step Including An Ability To Explain Problems Clearly And Extend The Main Idea For More Completion. (Worapoj Wongkitrungruang And Atip Chitruek, 2013; Pimpan Dachakupt, 2014; Osborn, 1953; Weir, 1974; Parnes, 1976; Guilford, 1988; Baroody, 1993; Hart, 1993; Krulik And Rudnick, 1993; Ellison, 1995; Puccio, 1999; Lewin And Reed, 1998; Treffinger, 2005 And Carvalho And Hopko, 2009)

In The Present, The Learning Of Undergraduate Students In Computer Especially Subject Related To Programming Shows That Most Students Cannot Solve Problems Assigned By Teachers Because They Are Lack Critical Thinking Skills To Solve Problems And Creative Thinking Skills. Students Cannot Break Down Or Analyze Problems And Find Solutions. Therefore, They Cannot Write Code To Solve Problems. These Skills Are Essential In The 21st Century. If Students Lack These Skills, They Will Have Problems In Their Careers. Therefore, Teachers In The Computer Field Have To Find Different Ways Of Learning Management To Develop Skills In Students. The Learning Management For Creative Problem-Solving Is A Concept Of Child Centered Learning Management Using Problems Or Objectives To Stimulate The Learning Of Students Based On Creativity. The Learning Can Be Done As An Individual, Group Process, Or Cooperatives Learning. Results Are Recorded And Discussed. These Activities Are Done By Students And Teachers Only Support. Therefore, If Computer Students Have Creative Problem- Solving Skills, They Will Be Able To Analyze Problems In Different Aspects Such As What Problems Need, What Problems Are, What Information Is Related, And How To Code Programs.

Expected Benefits From The Study Of Creative Problem-Solving Skill Components Of Undergraduate Students Are To Know Skill Components Of Creative Problem-Solving Skill For Teachers To Find Guidelines Or Plans The Teaching And Learning Management Including Activities To Support The Teaching And Learning Management And Develop Students For Creative Problem-Solving Skill. These Skills Will Help Students In Terms Of Study And Daily-Life Problem Solving. Students Can Develop Skills And Abilities Of Creative

Problem Solving. Although Students Have Skills, The Practice Will Develop The Efficiency Of Creative Problem Solving.

From The Importance Of Creative Problem-Solving Skills, The Author Interest In The Analysis Of Creative Problem-Solving Skill Components Of Undergraduate Students Using Confirmation Factor Analysis To Study Creative Problem-Solving Skill Components To Plan The Development Of Students To Have Creative Problem-Solving Skills.

Objective
To Analyze Creative Problem-Solving Skill Components Of Undergraduate Students.

Scope Of Study
Population And Samples: Population Is Teachers Of Graduate Users In 104 Schools In Bangkok. Samples Are Teachers Or Graduate Users In 83 Schools In Bangkok. 4 Questionnaires Will Be Sent To Each School So The Total Number Is 332. The Number Of Schools Is Defined By Using Simple Random Sampling. Sample Size Determination Is Done According To Schumacker And Lomax (2010) And Hair, Black, Babin, And Aderson (2010) For Confirmation Factor Analysis. The Sample Size Of This Study Is 20 Times (1:20) Of Observation Variables Which Equal To 16. Therefore, The Sample Size Is 320.

Methodology
This Study Is A Quantitative Study To Validate Definitions, Components, And Develop The Creative Problem-Solving Skill Of Undergraduate Students Using Confirmation Factor Analysis.

Tools Are Questionnaires About The Creative Problem-Solving Skill Of Undergraduate Students Which Consist Of 2 Parts, Namely, Part 1 General Information Questionnaires And Part 2 Questionnaires About Creative Problem-Solving Skill With 5- Likert Scale That Verified For Content Validity By 5 Experts. It Is Found That Ioc (Index Of Item-Objective Congruence: Ioc) (Sirichai Kanjanawasee, 2001) Is 1.00. The Reliability Is 0.94. Statistics Used To Analyze Are Frequency, Percentage, Mean, Standard Deviation, And Confirmation Factor Analysis.

Results
To Analyze Creative Problem-Solving Skill Components Of Undergraduate Students, The Author Uses Confirmation Factor Analysisand The Results Can Be Analyzed As Follows:

1. **General Information Of Samples** Who Are 332 Teachers Of Graduate Users In Schools Under Secondary Educational Service Area Office, Area 1 And Bangkok Primary Educational Service Area Office. They Are Classified By Personal Characteristics, Namely, Gender, Age, Educational Background, And Work Experience. The Author Analyzes Data Using Frequency And Percentage When Results Are Shown In Table 1.

Table1 Results Of General Data Analysis Of Questionnaire Respondents

General Information		**Number**	**Percentages**
Gender	Male	80	24.10
	Female	252	75.90
	Total	**332**	**100.00**
Age	Less Than 30 Years Old	207	62.40
	30 – 35 Years Old	69	20.80
	36 – 40 Years Old	30	9.00
	41 – 45 Years Old	13	3.90
	46 – 50 Years Old	13	3.90
	More Than 51 Years Old	0	0.00
	Total	**332**	**100.00**
Education Level	Bachelor Degree	308	92.80
	Master Degree	22	6.60
	Doctoral Degree	2	0.60
	Other	0	0.00
	Total	**332**	**100.00**
Work Experience	1 – 5 Years	251	75.60
	6 – 10 Years	55	16.60
	11 – 15 Years	13	3.90
	16 – 20 Years	9	2.70
	21 – 25 Years	0	0.00

	More Than 26 Years	4	1.20
	Total	**332**	**100.00**

From Table1, Most Questionnaire Respondents Are Females With The Number Of 252, 207 Of Them Are Younger Than 30 Years Old, 308 Of Them Obtained A Bachelor's Degree, And 251 Of Them Have Work Experience Of 1-5 Years.

2. **Results Of Creative Problem-Solving Skill From Confirmation Factor Analysis Of Undergraduate Students Using First Order Confirmation Factor Analysis** Consist Of 16 Questions According To The Observation Variables List That Cover 4 Skills Which Are Originality, Fluency, Flexibility, And Elaboration. Results From The Analysis Of Each Aspect Can Be Shown As Follows:

Table 2 Results Of First Order Confirmation Factor Analysis In Originality Aspect

Originality	**B**	**T**	**Se**	**R^2**
1) Has An Ability To Solve Problems Using New Idea (A1)	0.82	6.32**	0.05	0.67
2) Has An Ability To Solve Problems Using Idea Which Different From A Familiar Idea (A2)	0.76	8.15**	0.05	0.58
3) Has An Ability To Solve Problems Applying The Traditional Ideas For More Efficiency (A3)	0.71	9.57**	0.05	0.51

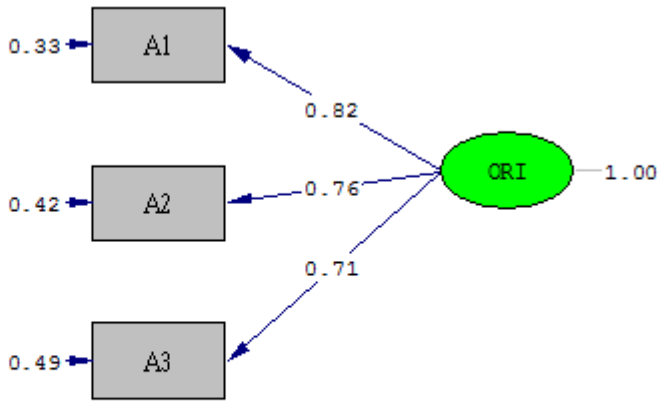

Figure 1 First Order Confirmation Factor In Originality Aspect

From Table 2 And Figure 1, The Variable Which Has The Highest Weight In Originality (A) Is An Ability To Solve Problems Using A New Idea (A1) When The Weight Is 0.82 And Joint Variation Of Originality (A) Is 67% Followed By An Ability To Solve Problems Using Idea Which Different From A Familiar Idea (A2) When The Weight Is 0.76 And Joint Variation Of Originality (A) Is 58%. The Last Is An Ability To Solve Problems Applying The Traditional Ideas For More Efficiency (A3) When The Weight Is 0.71 And Joint Variation Of Originality (A) Is 51%.

Table 3 Results Of First Order Confirmation Factor Analysis In Fluency Aspect

Fluency	**B**	**T**	**Se**	**R^2**
1) Has An Ability To Solve Problems Fast (B4)	0.82	5.16**	0.06	0.67
2) Has An Ability To Solve Problems Efficiently (B5)	0.75	7.37**	0.06	0.56
3) Has An Ability To Solve Problems Using Different Solutions In A Limited Time (B6)	0.62	10.68**	0.06	0.38

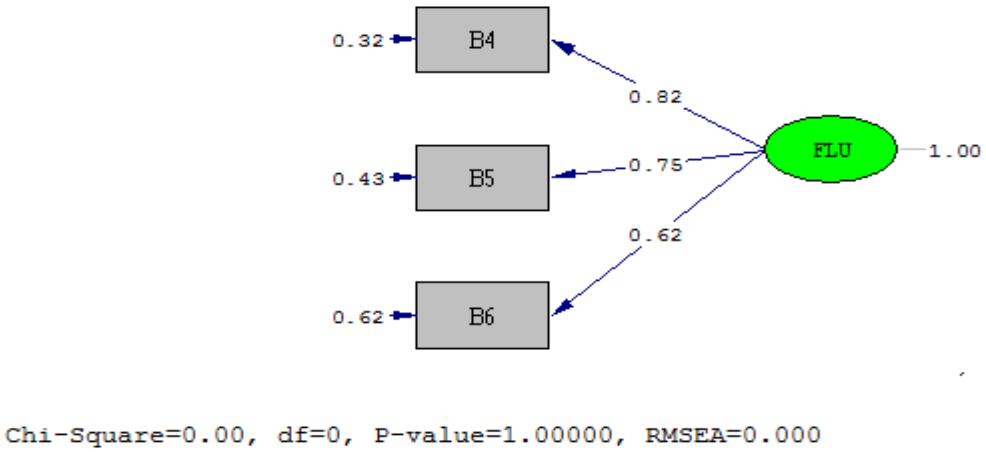

Figure 2 First Order Confirmation Factor In Fluency Aspect

From Table 3 And Figure 2, The Variable Which Has The Highest Weight In Fluency (B) Is An Ability To Solve Problems Fast (B4) When The Weight Is 0.82 And Joint Variation Of Fluency (B) Is 67% Followed By An Ability To Solve Problems Efficiently (B5) When The Weight Is 0.75 And Joint Variation Of Fluency (B) Is 56%. The Last Is An Ability To Solve Problems Using Different Solutions In A Limited Time (B6) When The Weight Is 0.62 And The Joint Variation Of Fluency (B) Is 38%.

Table 4 Results Of First Order Confirmation Factor Analysis In Flexibility Aspect

Flexibility	**B**	**T**	**Se**	**R^2**
1) Has An Ability To Solve Varied Kinds Of Problem (C7)	0.64	10.94**	0.05	0.41
2) Has An Ability To Classify Groups Of An Idea To Solve Problems (C8)	0.69	9.60**	0.05	0.47
3) Has An Ability To Solve Problems By Modifying An Idea To A Different Idea (C9)	0.78	8.46**	0.05	0.61
4) Has An Ability To Solve Problems By Adapting The Idea To Different Situations (C10)	0.84	5.50**	0.05	0.71
5) Has An Ability To Solve Problems By Selecting Proper Solutions Depending On Situations Or Conditions (C11)	0.74	8.65**	0.05	0.55

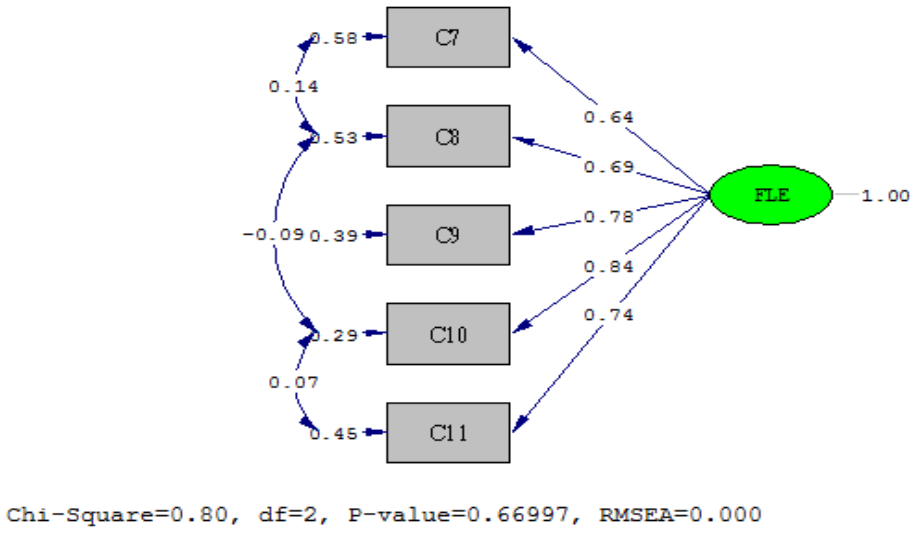

Figure 3 First Order Confirmation Factor In Flexibility Aspect

From Table 4 And Figure 3, The Flexibility (C) Component Which Has The Highest Weight Is An Ability To Solve Problems By Adapting The Idea To Different Situations (C10) When The Weight Is 0.84 And Joint Variation Of Flexibility (C) Is 71% Followed By An Ability To Solve Problem By Modifying An Idea To

Different Idea (C9) When The Weight Is 0.78 And Joint Variation Of Flexibility (C) Is 61%. The Next Is An Ability To Solve Problems By Selecting Proper Solutions Depending On Situations Or Conditions (C11) When The Weight Is 0.74 And Joint Variation Of Flexibility (C) Is 55% Followed By An Ability To Classify Groups Of An Idea To Solve Problems (C8) When The Weight Is 0.69 And Joint Variation Of Flexibility (C) Is 47%. The Last Is An Ability To Solve Varied Kinds Of Problem (C7) When The Weight 0.64 And Joint Variation Of Flexibility (C) Is 41%.

Table 5 Results Of First Order Confirmation Factor Analysis In Elaboration Aspect

Elaboration	**B**	**T**	**Se**	**R^2**
1) Has An Ability To See Detail Which Other People Do Not See (D12)	0.70	10.83**	0.05	0.49
2) Has An Ability To Solve Problems Step By Step (D13)	0.87	8.17**	0.03	0.76
3) Has An Ability To Solve Problems Using Elaboration (D14)	0.88	7.51**	0.03	0.77
4) Has An Ability To Solve Problems By Explaining Problems Clearly (D15)	0.81	10.17**	0.03	0.65
5) Has An Ability To Solve Problems By Modifying Or Extending The Main Idea For More Completion (D16)	0.75	10.92**	0.04	0.56

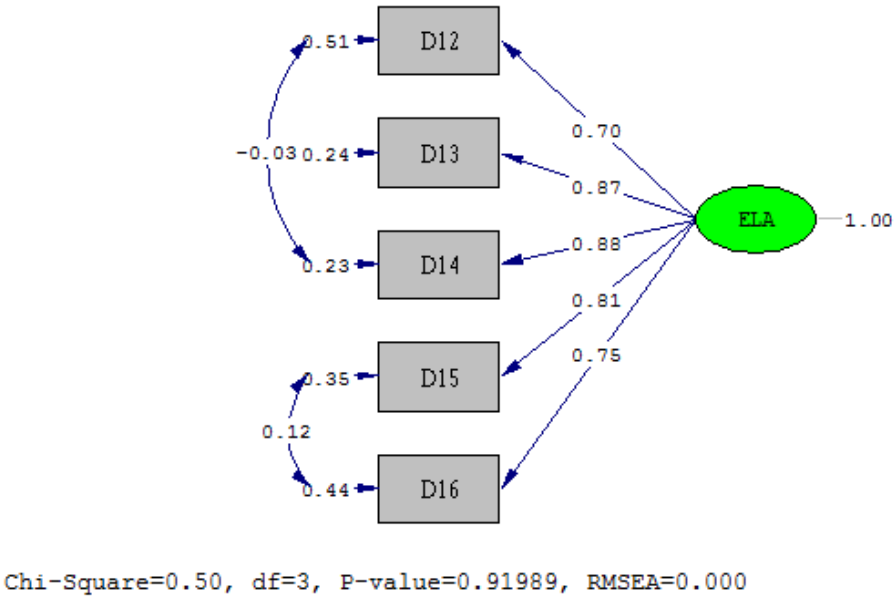

Figure 4 First Order Confirmation Factor In Elaboration Aspect

From Table 5 And Figure 4, The Variable Of Elaboration (D) Component With The Highest Weight Is An Ability To Solve Problems Using Elaboration (D14) When The Weight Is 0.88 And Joint Variation Of Elaboration (D) Is 77% Followed By An Ability To Solve Problems Step By Step (D13) When The Weight Is 0.87 And Joint Variation Of Elaboration (D) Is 76%. The Next Is An Ability To Solve Problems By Explaining Problems Clearly (D15) When The Weight Is 0.81And Joint Variation Of Elaboration (D) Is 65% Followed By An Ability To Solve Problems By Modifying Or Extending The Main Idea For More Completion (D16) When The Weight Is 0.75 And Joint Variation Of Elaboration(D) Is 56%. The Last Is An Ability To See Detail Which Other People Do Not See (D12) When The Weight Is 0.70 And Joint Variation Of Elaboration (D) Is 49%.

3. **Results Of Creative Problem-Solving Skill Confirmation Factor Analysis Of Undergraduate Students Using Second Order Confirmation Factor Analysis.** The Analysis Of Goodness Of Fit (Gfi) Of Component Model And Empirical Data Of Creative Problem-Solving Skill Components Of Undergraduate Students Can Be Shown As Followed:

Table 6 Gfi Of The Component Model And Empirical Data Of Creative Problem-Solving Skill Components Of Undergraduate Students

No	**Gfi**	**Criteria**	**Adjusted Value**	**Result**
1	χ^2-Test Or χ^2-Sig (P)	P>0.05	1.00	Pass
2	χ^2/Df	<2	0.35	Pass

3	Gfi	≥0.95	0.99	Pass
4	Agfi	≥0.95	0.98	Pass
5	Pgfi	≤ 0.50	0.36	Pass
6	Nfi	≥ 0.95	0.99	Pass
7	Nnfi	≥ 0.95	1.01	Pass
8	Pnfi	≤ 0.50	0.42	Pass
9	Cfi	≥ 0.95	1.00	Pass
10	Ifi	≥ 0.95	1.00	Pass
11	Rmsea	≤ 0.05	0.00	Pass
12	Srmr	≤ 0.05	0.01	Pass
13	Rmr	≤ 0.05	0.01	Pass

Table 6 Is The Validation Of Gfi Of The Component Model And Empirical Data Of Creative Problem-Solving Skill Components Of Undergraduate Students. It Is Found That Chi-Square (χ^2) = 1.00, χ^2/Df = 0.35, Gfi = 0.99, Agfi = 0.98, Pgfi = 0.36, Nfi = 0.99, Nnfi = 1.01, Pnfi = 0.42, Cfi = 1.00, Ifi = 1.00, Rmsea = 0.00, Srmr = 0.01, And Rmr = 0.01. From The Results, The Component Model Has Gfi And Empirical Data That Means The Developed Component Model Can Explain The Component Model Of Creative Problem-Solving Skill Of Undergraduate Students When Creative Problem-Solving Skills Consist Of 4 Aspects Which Are Originality, Fluency, Flexibility, And Elaboration. The Confirmation Factor Analysis Can Be Shown In Figure 5 And Table 7.

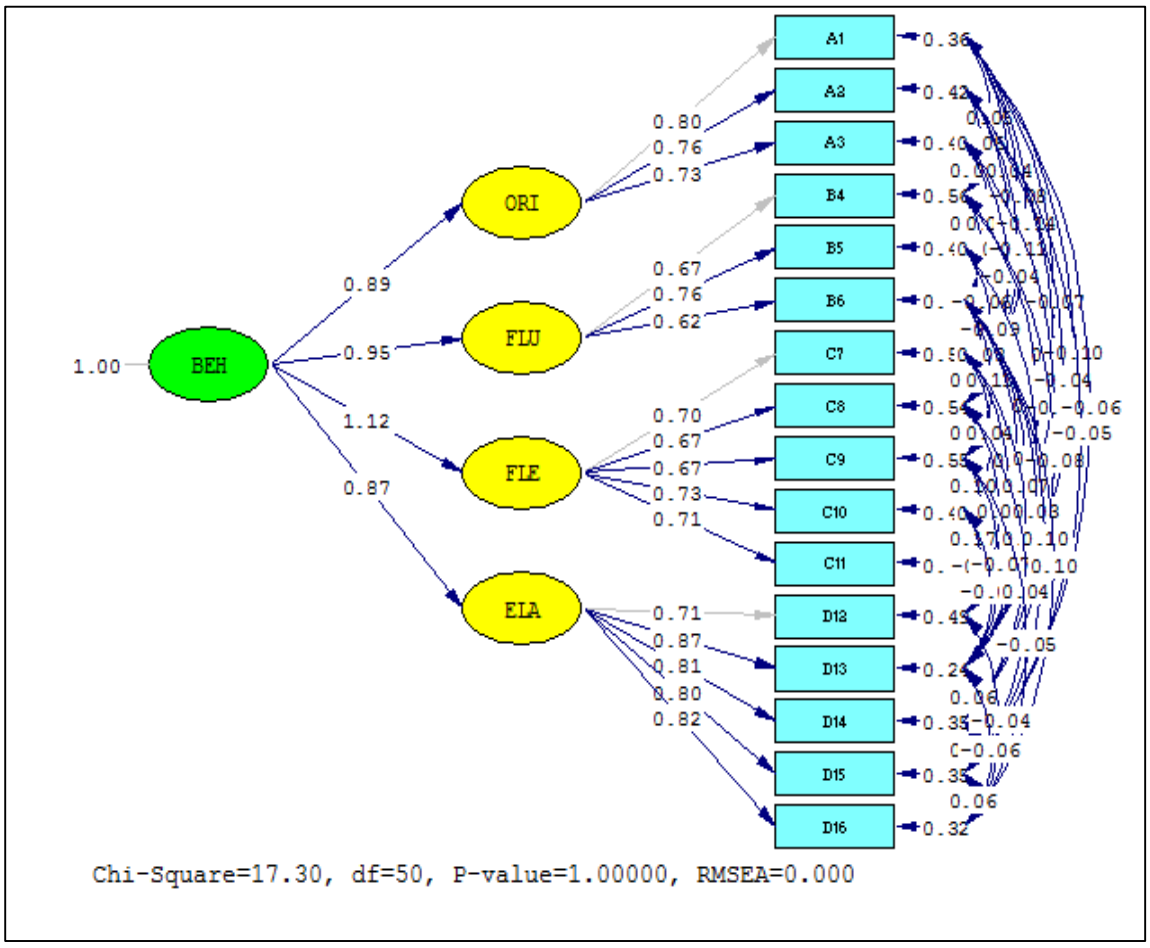

Figure 5 The Component Model Of Creative Problem-Solving Skill Of Undergraduate Students

Table 7 Results From The Analysis Of Creative Problem-Solving Skill Components Of Undergraduate Students

Variables	$\bar{x}$	**S.D.**	**Factor Loading**				**Factor Score Coefficient**
			B	**S.E**	**T**	**R^2**	

1. Originality (A)	**3.87**	**0.65**	**0.89**	**0.06**	**14.50**	**0.79**	
1) Has An Ability To Solve Problems Using New Idea (A1)	3.83	0.63	0.80	0.05	14.50**	0.64	0.37
2) Has An Ability To Solve Problems Using Idea Which Different From A Familiar Idea (A2)	3.81	0.66	0.76	0.05	13.66**	0.58	0.21
3) Has An Ability To Solve Problems Applying The Traditional Ideas For More Efficiency (A3)	3.97	0.66	0.73	0.05	13.11**	0.53	0.18
2. Fluency (B)	**3.88**	**0.72**	**0.95**	**0.07**	**12.57**	**0.90**	
1) Has An Ability To Solve Problems Fast (B4)	3.84	0.71	0.67	0.05	12.57**	0.44	0.05
2) Has An Ability To Solve Problems Efficiently (B5)	3.99	0.72	0.76	0.05	14.73**	0.58	0.21
3) Has An Ability To Solve Problems Using Different Solutions In A Limited Time (B6)	3.82	0.72	0.62	0.05	11.23**	0.38	0.04
3. Flexibility (C)	**3.90**	**0.73**	**1.12**	**0.07**	**15.53**	**1.26**	
1) Has An Ability To Solve Varied Kinds Of Problem (C7)	3.92	0.75	0.70	0.05	15.53**	0.49	0.07
2) Has An Ability To Classify Groups Of An Idea To Solve Problems (C8)	3.85	0.73	0.67	0.05	14.35**	0.46	0.06
3) Has An Ability To Solve Problems By Modifying An Idea To A Different Idea (C9)	3.83	0.70	0.67	0.05	15.16**	0.45	0.04
4) Has An Ability To Solve Problems By Adapting The Idea To Different Situations (C10)	3.97	0.72	0.73	0.05	17.34**	0.54	0.06
5) Has An Ability To Solve Problems By Selecting Proper Solutions Depending On Situations Or Conditions (C11)	3.92	0.72	0.71	0.05	16.55**	0.51	0.05
4. Elaboration (D)	**3.91**	**0.76**	**0.87**	**0.07**	**12.70**	**0.75**	
1) Has An Ability To See Detail Which Other People Do Not See (D12)	3.76	0.75	0.71	0.05	12.70**	0.51	0.13
2) Has An Ability To Solve Problems Step By Step (D13)	3.96	0.78	0.87	0.05	15.86**	0.76	0.38
3) Has An Ability To Solve Problems Using Elaboration (D14)	3.92	0.78	0.81	0.05	14.48**	0.65	0.04
4) Has An Ability To Solve Problems By Explaining Problems Clearly (D15)	3.98	0.74	0.80	0.05	14.52**	0.65	0.12
5) Has An Ability To Solve Problems By Modifying Or Extending The Main Idea For More Completion (D16)	3.94	0.75	0.82	0.05	14.90**	0.68	0.26

** P < .01

From Figure 5 And Table 7, The Creative Problem-Solving Skill Components Of Undergraduate Students Consist Of 4 Aspects From 16 Observation Variables. They Are Creative Problem-Solving Skill Components Of Undergraduate Students That Have Harmoniousness With Empirical Data. Therefore, It Can Be Concluded That The Creative Problem-Solving Skill Components Of Undergraduate Students Consist Of 4 Aspects. The Aspect With The Highest Weight Is Flexibility (C) When The Weight Is 1.12 Followed By Fluency (B) When The Weight 0.95, Originality (A) When The Weight Is 0.89, And Elaboration (D) When The Weight Is 0.87 Respectively. For The Overall Mean Of Each Aspect, The Mean Of Every Component Is High (3.87 – 3.91). The Component With The Highest Mean Is Elaboration When The Mean Is 3.91 Followed By Flexibility When The Mean Is 3.90, Fluency When The Mean Is 3.88, And Originality When The Mean Is 3.87 Respectively.

Discussion

The Analysis Of Creative Problem-Solving Skill Components Of Undergraduate Students Consists Of 16 Questions According To The List Of Observation Variables That Cover 4 Aspects Which Are Originality, Fluency, Flexibility, And Elaboration. The Analysis Shows That The Creative Problem-Solving Skill Component Model Has Gfi With Empirical Data That Means The Developed Component Model Can Explain

The Component Model Of Creative Problem-Solving Skill Of Undergraduate Students. The Creative Problem-Solving Skills Consist Of 4 Components When The Component With The Highest Weight Is Flexibility Or The Ability To Solve Varied Kinds Of Problem By Classifying And Modifying An Idea To Different Ideas To Solve Problems By Adapting Ideas With Different Situations And Select Proper Solutions Depending On Situations Or Conditions. The Result Is Conformed To The Concept By Torrance (1964) Who Said Flexibility Is Fundamental To Creativity Which Can Be Many Aspects, Types, And Categories. Therefore, Flexibility Can Increase The Quality Of Creativity. The Second Is Fluency Or The Ability To Solve Problems Fast And Efficiently Using Different Solutions In A Limited Time. This Is Conformed To Aree Panmanee (2004) Who Found That Fluency Is The Component Of Creativity Related To The Fast And Massive Response In A Limited Time. Fluency Is One Of The Important Ideas To Be Creative Because It Leads To The Selection Of The Best Idea And Most Suitable Idea That Needs Variety. Therefore, Fluency Is A Fundamental Ability For Creativity. The Third Is Originality Or An Ability To Solve Problems Using New Ideas Different From Familiar Ideas And Applying The Traditional Ideas For More Efficiency. This Is Conformed To Aree Panmanee (2004) Who Found That Originality Is The Second Importance Which Different From The Traditional Idea From Applying It And Develop A New Idea. The Fourth Is Elaboration Or The Ability To See Detail Which Other People Do Not See To Solve Problems Step By Step Using Elaboration And Explaining Problems Clearly Including Modifying Or Extending The Main Idea For More Completion. This Is Also Conformed To Aree Panmanee (2004) Who Found That Elaboration Is Related To Detailed Thinking To Respond And Extend The Original Idea For More Completion.

However, Developing Students To Have Creative Problem-Solving Skills Needs 4 Components To Support Them. Guilford (1988) Mentioned Important Components To Make Persons Have Creativity Consisting Of Fluency, Flexibility, Originality, And Elaboration. Moreover, It Is Conformed To Pornsawan Vongthatam (2015) Who Said Creative Thinking Is A Thinking Process To Solve Complex Problems Based On The New Varied Idea Using Convergent Thinking That Requires Knowledge And Experience In Terms Of Flexibility And Elaboration That Support Each Other To Solve Problems In The 21st Century.

Suggestions

1. The Results Show That The Problem Solving Skill With The Highest Weight Is Flexibility That Means Graduate Users Or Teachers In The Present Need To Make Students Have Flexibility As The First Priority. Therefore, Teachers In University Should Support Them To Have It. It Can Be Done By Organizing Training Or Including Skill Practice In Subjects To Consistent With The Requirements Of Graduate Users Or Teachers.
2. Related Persons Can Apply The Results To Plan The Learning Management Or Design Learning Management For Students To Develop Creative Problem-Solving Skills That Consistent With The Required Skills In The 21st Century.

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