Construction Measurement Critical Thinking

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Abstract. Critical thinking is a prerequisite to participate effectively in the various aspects of life. Critical thinking skills include the ability to identify, analyze, evaluate, verbal and written arguments. Writers often identify that a number of students have the ability to think critically, but the conclusion is not always true. On that basis it is necessary to develop a measuring tool of critical thinking skills of students, which in particular can be used to measure critical thinking skills in the classroom or the test of critical thinking in general. This paper aims to find out the results validity, reliability, normality of the distribution of respondents and distribution of the items on the indicator measuring devices critical thinking skills. This study used a sample of 60 students. They learn in the classroom by using the method of discussion during the three meetings. They were asked to evaluate other students who have a duty to present papers. After the learning process is complete they tested. Results of the *first* study, the development of critical thinking skills common items as much as 53 statement. Having to test the validity, factor analysis and test for normality of the distribution of answers (Likert) gained 12 statement items that can be used. Results of reliability tests with Cronbach's Alpha coefficients have Cronbach's Alpha reliability coefficient of 0.819> 0.8. *Second*, the development of critical thinking skills limited items as much as 27 statement. Having to test the validity, factor analysis and test for normality of the distribution of answers (Likert) gained 12 statement items that can be used. Results of reliability tests with Cronbach's Alpha coefficients have Cronbach's Alpha reliability coefficient of 0.87> 0.8.

Keywords: Construction of measuring instruments, critical thinking, and learning methods

Introduction

Research has demonstrated the need to improve critical thinking skills among students, because many of them fail to take advantage of reasoning (Halpern, 1998; Kuhn, 1999). Critical thinking skills is a must for success in modern life, as a step to addressing the changes are rapid and complex. Nowadays people are not expected to know their place, but to determine their position (Ten Dam & volman, 2004). When life goes, a supposedly able to make rational decisions based on critical thinking instead of accepting the authority. Therefore, students must be prepared to question the axioms, raises doubts, investigate the situation, and the investigation of alternative (critical thinking), in the context of two schools (colleges) and everyday life (Miri, David & Uri, 2007). Critical thinking is an ability that is essential for life, work and function effectively in all other aspects of life (Simpson & Courtnery, 2007; Snyder & Snyder, 2008; Scott, 2008; Kennedy, 2009; Yildirim & Ozkahraman, 2011; Hall, 2011).

This paper describes how the procedure of development of critical thinking skills. The author divides the critical thinking skills into two, namely: critical thinking skills in general and critical thinking skills are limited (specific). Critical thinking skills in general is thought that eksplitsit based on a reasoned judgment and based on appropriate standards in order to seek the truth, profits and the value of something. While the limited ability of critical thinking is the ability of students to give an explanation, argue, conclude based on the evidence.

Literature Review

Paul and Elder (2006) developed a model of critical thinking, known as a model of critical thinking Paul & Elder. He explained that there are three components of critical thinking, namely: elements of reasoning, intellectual standards, and intellectual traits. The elements of reasoning is universal elements that inform and explain all the reasons or the mind. Intellectual standard is the standard applied to the elements of reasoning or thinking to interpret or judge the quality. Finally, intellectual traits is desired traits or characteristics of a skilled practitioner of critical thinking. The three components are interrelated and each contributes to the development of critical thinkers.

In detail elements of reasoning divided into eight sections, namely: purposes, questions, assumption, points of view, information, concepts and ideas, inference and implication. Intellectual standards are divided into nine intellectual standards of reasoning, namely: clarity, accuracy, precision, relevance, depth, breadth, logic, significance, and fairness. While the intellectual traits reasoning thinking, such as intellectual humility, intellectual courage, intellectual empathy, intellectual integrity, intellectual perseverance, confidence reason, and fair-mindedness.

The author does not take all the elements of critical thinking put forward by Paul & Elder, but simplify according to the needs on the ground. Writer combines elements of reasoning and intellectual standards. Standard intellectual reasoning used is clarity, logicalness, depth, and breadth. While the elements of reasoning used is information, concepts, and points of view. Thus it can be formulated into the clarity of information; depth ideas; breadth of viewpoint, and clarity in the inference.

Table 1. Indicators of critical thinking skills

Variable	Indicator	No. Item tes	No. Item rating scales
Critical thinking skills	clarity of information	1-15	1-6
	depth of ideas	16-27	7-14
	breadth viewpoint	28-41	15-23
	precision in inference	42-53	24-27

Ash and Clayton (2009) confirms the critical thinking indicators can be used both as a guide to improve the reasoning student formative and summative tool for evaluating the quality at the end of learning. Thus researchers develop critical thinking instruments into two. *First*, develop critical thinking skills based on learning in the classroom (limited critical thinking). This instrument was developed in the form of rating scales produce 27 items a statement. *Second*, these instruments were developed in the form of student tests used. The instrument used to collect data that are informative-factual (concrete facts). The development of tests based on indicators developed in Table 1 produces 53 item statement.

Procedure Development and Testing Instruments

Authors developed the instrument with the following procedure: the consultation of experts, the revision of instruments, test instruments in the group of students, test reliability, validity, factor analysis and test for normality of the distribution of answers using the method of Summated rating (Likert). *First*, the authors consult the expert to find the suitability of language theory translated into operational language as a means of data collection. Revision of the instrument is done in order to correct language errors, discrepancies concept, writing and other errors. *Second*, the test instrument performed on 60 students; trials conducted two stages; namely: critical thinking skills tests and rating scales to think critically.

Procedures critical thinking skills test given to 60 students, they were asked to complete a 53 item statement. While rating scales to first prepare a discussion class, having completed the process of discussion the audience was asked to pass judgment on the groups that appear on the 27 item rating scales. *Third*, test reliability and validity of the instrument. Reliability testing using the formula of Cronbach's Alpha. Anastasi (1982) describes the reliability of the ideal is 0.8; and items declared valid if the corrected item-total correlation is above 0.30. *Fourth*, factor analysis was used to identify the relatively small number of

factors that can be used to describe a large number of indicators that are interconnected, so that the indicators in the factors have a high correlation, while the correlation with indicators in other factors are relatively low. *Fifth*, test the normality of the distribution of the answers using the method of Summated rating (Likert), this stage is a statement scaling method using the distribution of responses as the basis for determining the scale and do not use assessment group.

Results and Discussion

Critical thinking is limited

Results of rating scales development of critical thinking skills:
1.   Test reliability was obtained Cronbach's alpha value of 0.893 and the value of the item corrected item-total correlation <0.3 is item 5 and 15. This means that there are 25 items that otherwise invalid;
2.   Test the second stage by removing items 5 and 15, so that the Cronbach's alpha values obtained 0.901;
3.   Factor analysis showed that the items are still scattered on the 7 factors / indicators, meaning that 25 items have not yet set up a 4 factors / indicators that are expected;
4.   Discard the 5 items that values corrected item-total correlation lows, then obtained a Cronbach's alpha of 0.903 and 20 items;
5.   Continuing with the analysis normality of the distribution of answers, 20 items were analyzed: items 2, 3, 7, 8, 9, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24 , 25 and 27 (see example in Table 2, table 3 and table 4).

Table 2. Normality of the distribution of answers to item 2

Alternative	NS A.	F	F P	CP	MCP	Z	Z+3.282	NS K.
R	2	12	0.200	0.200	0.100	-1.282	2	2
S	3	30	0.500	0.700	0.450	-0.126	3.156	3
SS	4	18	0.300	1.000	0.850	1.036	4.318	4
	Total	60						

Table 3. Normality of the distribution of answers to item 3

Alternative	NS A.	F	P	CP	MCP	Z	Z+2.960	NS K.
TS	1	3	0.050	0.050	0.025	-1.96	1	1
R	2	17	0.283	0.333	0.192	-0.871	2.089	2
S	3	24	0.400	0.733	0.533	0.083	3.043	3
SS	4	16	0.267	1.000	0.867	1.112	4.072	4
	Total	60						

Table 4. Normality of the distribution of answers to item 7

Alternative	NS A.	F	P	CP	MCP	Z	Z+3.572	NS K.
R	2	7	0.117	0.117	0.058	-1.572	2	2
S	3	36	0.600	0.717	0.417	-0.21	3.362	3
SS	4	17	0.283	1.000	0.858	1.071	4.643	5
	Total	60						

Information:

F   frequency response for each category of response, overall frequency when added as much as the respondents (N), in this example 60 people.

P   is obtained by dividing each frequency by the number of respondents.

CP   (cumulative proportion), the proportion of a category of response coupled with the proportion of all of the category next to his left.

MCP	the midpoint of the cumulative proportion defined as half the proportion in the relevant category plus the cumulative proportion in his left categories, namely;
MCP	½p+cpb
Cpb	the cumulative proportion in the categories on the left.
Z	Deviation value is obtained by looking at each MCP of normal deviation tables.

6. The item about the good, and therefore could be used is the distribution of its Z value of 0, 1, 2, 3, 4. Items that are not normally not used as shown in Table 4 item 7, so that 20 items were tested for normality of the distribution of answers was only 12 items fit for use as follows: items 2, 3, 12, 14, 16, 17, 20, 21, 22, 23, 25, and 27.

7. The final results of reliability test of critical thinking skills of the 12 items obtained a Cronbach's alpha 0.870 (Table 5), while the validity of the instrument can be seen in Table 6;

Table 5. Reliability statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.870	0.870	12

Table 6. Item-total statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation
item_2	31.8333	33.260	.529
item_3	32.0500	31.743	.571
item_12	32.1833	31.847	.623
item_14	32.0000	32.407	.533
item_16	31.7833	32.342	.579
item_17	31.9500	33.201	.499
item_20	31.8167	32.932	.470
item_21	32.2500	31.953	.575
item_22	31.9500	31.370	.662
item_23	32.0167	33.237	.480
item_25	32.2000	30.739	.671
item_27	32.2333	33.301	.473

8. The next stage of the analysis that the third factor. Item spread on 4 factors / indicators with a cumulative 71.04%. Distribution in Table 7 for compatibility with indicators that are drafted;

Table 7. Total variance explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.976	41.469	41.469	4.976	41.469	41.469
2	1.479	12.327	53.797	1.479	12.327	53.797
3	1.173	9.775	63.572	1.173	9.775	63.572
4	.896	7.468	71.040	.896	7.468	71.040
5	.868	7.233	78.274			
6	.546	4.554	82.827			
7	.494	4.114	86.942			
8	.424	3.532	90.473			

9	.373	3.108	93.581
10	.309	2.572	96.154
11	.240	1.998	98.152
12	.222	1.848	100.000

Extraction Method: Principal Component Analysis.

Table 8. explained that items 20, 21, 22, and 25 incoming indicators (factors) 1, the number of 4 items. While items 2, 3, and 14 incoming indicators (factors) 2, the number of 3 items. Whereas item 16, 17, and 27 incoming indicators (factors) 3, the number of 4 items. Last items 12 and 23 into the indicator (factor) 4, the number 2 item.

Table 8. Rotated component matrix

	Component			
	1	**2**	**3**	**4**
item_2		.837		
item_3		.772		
item_12				.765
item_14		.648		
item_16			.683	
item_17			.754	
item_20	.725			
item_21	.771			
item_22	.685			
item_23				.767
item_25	.655			
item_27			.738	

Critical thinking in general

Results of the development of critical thinking skills test:

1. Test reliability was obtained alpha Cronbach's 0.855 and items that values corrected item-total correlation <0.3 is item (2, 3, 4, 10, 11, 19, 22, 23, 24, 27, 30, 36, 37, 39, 40, 41, 42, 44, 47, 48, 49, 51, 52, and 53). It means that there are only 29 items were declared invalid;

2. Test the second stage by removing the 24-item validity value <0.3 then obtained a Cronbach's alpha 0.868 and 29 items have value corrected item-total correlation> 0.3;

3. Next do a factor analysis of the 29 items. Results of factor analysis of the items are still scattered on 6 factors / indicators, meaning that 29 items have not yet set up a 4 factors / indicators that are expected;

4. The next step is to dispose of items that values corrected item-total correlation <0.4, obtained a Cronbach's alpha and the remaining 0.866 to 18 items;

5. Analyze normality of the distribution of answers, from the 18 items were analyzed: item 1, 5, 6, 8, 9, 12, 13, 15, 16, 18, 21, 25, 33, 34, 35, 38 and 50 (see the example in table 9, table 10 and table 11).

Table 9. Normality of the distribution of answers to item 1

Alternative	NS A.	F	P	CP	MCP	Z	Z+2.960	NS K.
TS	1	3	0.050	0.050	0.025	-1.960	1.000	1
R	2	6	0.100	0.150	0.100	-1.282	1.678	2
S	3	34	0.567	0.717	0.433	-0.169	2.791	3
SS	4	17	0.283	1.000	0.858	1.071	4.031	4
	Total	60						

Table 10. Normality of the distribution of answers to item 5

Alternative	NS A.	F	P	CP	MCP	Z	Z+3.409	NS K.
TS	1	1	0.017	0.017	0.008	-2.409	1	1
R	2	5	0.083	0.100	0.058	-1.572	1.837	2
S	3	31	0.517	0.617	0.358	-0.364	3.045	3
SS	4	23	0.383	1.000	0.808	0.871	4.28	4
	Total	60						

Table 11. Normality of the distribution of answers to item 15

Alternative	NS A.	F	P	CP	MCP	Z	Z+2.120	NS K.
TS	1	2	0.033	0.033	0.017	-2.120	0.000	0
R	2	6	0.100	0.133	0.083	-1.392	0.728	1
S	3	6	0.100	0.233	0.183	-0.904	1.216	1
SS	4	26	0.433	0.667	0.450	-0.126	1.994	2
	Total	60						

The item about the good, and therefore could be used is the distribution of its Z value of 0, 1, 2, 3, 4. Items that are not normally not used as shown in Table 11, item 15, that of the 18 items were tested for normality of the distribution of answers was only 12 items fit for use as follows: item 1, 5, 6, 8, 12, 13, 16, 18, 20, 25, 33, and 50.

6. Outcome reliability test critical thinking skills of the 12 items obtained a Cronbach's alpha 0819 (Table 12); whereas the validity of the instrument can be seen in Table 13.

Table 12. Reliability statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.819	0.827	12

Table 13. Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation
item_1	32.8833	26.410	0.489
item_5	32.7000	26.451	0.557
item_6	32.9833	26.423	0.546
item_8	32.9333	26.131	0.578
item_12	32.7167	24.410	0.575
item_13	33.0667	25.792	0.429
item_16	33.0500	26.828	0.469
item_18	33.3833	26.478	0.417
item_20	32.8667	26.524	0.550
item_25	33.2167	26.037	0.372
item_33	33.0833	26.823	0.378
item_50	32.7500	27.852	0.405

7. The next stage of the analysis that the third factor. Item spread on 4 factors / indicators with a cumulative 64.609%. Table 14 shows the distribution in accordance with the distribution of items with indicators that are drafted;

Table 14. Total variance explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	4.199	34.993	34.993	4.199	34.993	34.993
2	1.503	12.529	47.522	1.503	12.529	47.522
3	1.042	8.687	56.209	1.042	8.687	56.209
4	1.008	8.400	64.609	1.008	8.400	64.609
5	.824	6.870	71.479			
6	.725	6.044	77.523			
7	.607	5.055	82.578			
8	.523	4.355	86.933			
9	.454	3.783	90.716			
10	.397	3.312	94.028			
11	.367	3.060	97.088			
12	.349	2.912	100.000			

Extraction Method: Principal Component Analysis.

Table 15 can be explained that item 8, 16, 18, and 20 incoming indicators (factors) 1, the number of 4 items. While items 1, 33, and 50 incoming indicators (factors) 2, the number of 3 items. While item 5, 6, 12, and 13 incoming indicators (factors) 3, the number of 4 items. 25 last item entered into the indicator (factor) 4, the number 1 item.

Table 15. Rotated component matrix

	Component			
	1	**2**	**3**	**4**
item_1		.654		
item_5			.789	
item_6			.452	
item_8	.526			
item_12			.551	
item_13			.676	
item_16	.688			
item_18	.738			
item_20	.749			
item_25				.860
item_33		.817		
item_50		.638		

Conclusion

This paper concluded, first: step development of critical thinking skills common item in the form of test first consulted the expert, field trials, validity, reliability, factor analysis and normality of the distribution of answers. The development resulted in 53 statements, after conducting a series of tests and statistical tests obtained 12 statement items that can be used. Results of reliability tests with Cronbach's Alpha coefficients have Cronbach's Alpha reliability coefficient of 0.819> 0.8. Second, the development of critical thinking skills are limited items in the form of rating scales as much as 27 statement. Stage of development and

testing is done in the same way. After having carried out various tests and statistical tests obtained 12 statement items that can be used. Results of reliability tests with Cronbach's Alpha coefficients have Cronbach's Alpha reliability coefficient of 0.87> 0.8.

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