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Construct Validity and Reliability of Attitudes towards Chemistry of Science Teacher Candidates

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ABSTRACT

Developing students' positive attitude toward learning is one of the important things, because some researchers mention that attitudes toward the subjects are related to academic achievement. Teachers, in the implementation of learning can evaluate attitudes toward the subjects, in order to know how students' attitude toward learning that is/has been going on. Therefore, an attitude assessment is required for valid, reliable and practical learning. The purpose of this research is to develop a Likert scale type questionnaire that can measure students' attitudes toward chemistry. In this study initially has been compiled as many as 43 items. The items in the present scale were adapted from the Test of Science-Related Attitudes (TOSRA) and Attitudes towards Chemistry Lessons Scale (ATCLS). After the contents validation of the questionnaire by the expert, the questionnaire is tested on 245 college students. Determination of construct validity which is conducted with exploratory factor analysis obtained 32 items valid question. The result of factor analysis shows that the scale has nine factors that explain 62.105% of the total variance. In addition, it shows the finding of 'reliability coefficient (Cronbach' alpha) of 0.91. The results obtained showed that it has obtained valid and reliable questionnaires as a measuring tool that can be used to determine student attitudes toward chemistry in chemistry foodstuffs lectures.

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1. INTRODUCTION

Attitude toward science is one of important parts to generated students who are able to think scientifically as the scientist. The results of the study [1] indicate that the former success in chemistry courses as well as achievement in middle school had effects on high school students' intellectual and emotional attitudes toward chemistry. This finding supports the pattern established by previous research, suggesting that attitude and achievement are related.

Students who are negatively behave toward Science, for example, are not interested or afraid of causing them to fail in Science. Statements such as "I love chemistry" or "I hate chemistry" show positive or negative feelings toward chemistry. Various objects can be related to attitudes about science lessons, scientists, science in real life, the chemistry as a school subject, and etc. For example, students' attitudes toward chemistry as a branch of science and as a school subject may be different in nature and level. The attitude is a psychological construct which has cognitive, affective and behavioral components [2]-[4]. In Indonesia, based on the Regulation of the Minister of Education and Culture of the Republic of Indonesia number 65 of 2013, aspects of attitude consists of receiving, running, cherish, appreciate, and practice. Therefore, the aspect of attitudes in the chemistry study will be useful to improve the quality of learning chemistry.

Assessment is required to evaluate the attitudes toward lessons. There are several attitude assessments that are commonly used to evaluate attitudes. For instance, the Chemistry Attitude Scale (CAS) is a 76-item five-Point Likert-scale instrument. Similarly, the Questionnaire on Chemistry-Related Attitudes (QOCRA), a shortened and modified version of the Test of Science-Related Attitudes (TOSRA) originally developed by [5] consists of 30 Likert-scale items [6]. Test of Science-Related Attitudes (TOSRA) having an important place in this process. The Attitude towards Chemistry Lessons Scale (ATCLS) by utilizing the "Enjoyment of Science Lessons", which is a sub-scale of TOSRA, has been developed [7]. The Attitude toward Chemistry Lessons Scale (ATCLS) is developed by Cheung in Chinese is a Likert-scale measure consisting of seven-point 12 items. The Attitude Scale toward Chemistry (ASTC), developed by Geban, Ertepınar, Yılmaz, Altın & Şahbaz in 1994.

In chemistry education, [8] used a semantic differential format to develop items to measure attitudes toward chemistry and chemistry self-efficacy as part of their Chemistry Attitudes and Experiences Questionnaire (CAEQ). The Attitudes towards the Subject of Chemistry Inventory (ASCI) [9] was given to first year undergraduate nursing students at two universities. The ASCI is a twenty item semantic differential where each item is quantified with a seven point Likert scale. ASCI was originally validated in the US with undergraduates majoring in chemistry [9], and subsequently, a shorter version of the original 20 item questionnaire was developed by [10], also in chemistry undergraduates. The Attitude toward the Subject of Chemistry Inventory (ASCIv1) developed by [9] to measure student attitudes toward chemistry as a discipline was recently used to quantify chemistry attitudes of college level students in the Pacific Islands [11]. This shortened version (ASCIv2) has been used in Australia and the US [12], and contains eight items in two subscales, 'intellectual accessibility' congruent with the cognitive component of attitude, and 'emotional satisfaction' congruent with the affective component of attitude.

Non test instruments are stated to have construct validity, if they can be used to measure concepts as defined. For example, to measure attitudes toward chemistry it is necessary to first define what attitudes toward chemistry, after which a new instrument is prepared to measure attitudes toward chemistry by definition. So the purpose of testing the validity of the construct is to obtain evidence about how far the measurement results give the constructs of measured variables.

In developing a psychological test, factor analysis is very relevant to test the construct validity. This technique is conducted by analyzing the items of the instrument contained in a number of certain factors. These items have an element of common factor merged into a new factor. According to [13] there are four basic steps to carry out the analysis of factors, namely (1) calculate all correlation matrix for each variable, (2) conducted factor extraction. Some methods on extraction include: varimax method, quartimax method and equamax method. The use of Varimax in Rotation options is preferred because, according to [14]. Varimax method proved very successful as an analytic approach to get orthogonal rotation i.e. rotation with 90 degree angle on a factor, (3) conducted the rotation. Rotation is a method used in factor analysis to reduce data from some variables into fewer factors when using the extraction method still can not be obtained clear factor component; And (4) names every factor.

This study focuses on the development of student attitude assessment instrument toward chemistry by testing the construct validity using factor analysis. Instruments are arranged in the form of questionnaire with Likert scale. The Likert scales produce the highest reliability among other formats and others suggest that a semantic differential format may reduce the acquiesce bias when measuring positive psychological constructs [12] argue that it is important to use instruments that avoid redundancy and assessment fatigue in order to obtain quality data. Shorter instruments can also be useful to overcome the fatigue of respondents in reading and responding to questions. Attitude scale composed of four attitudes aspects toward chemistry refers to the attitude assessment of the chemical that was developed [4] and [7] include the difficulty of the chemistry course, the interest of the chemistry course, the usefulness of chemistry course for students' future career, and the importance of chemistry for students' life with point distribution as outlined in Table 1.

The research problems are formulated as follows: 1) How is the validity of the construct of student attitude assessment instrument toward the developed chemistry? and 2) How is the reliability of the student attitude assessment instrument on the developed chemistry?

The result of research of student attitude appraisal instrument toward chemistry is expected to give significant contribution among others: 1) academically, the result of this research can enrich the repertoire of knowledge/library of education on assessment, particularly in the result of a standardized and reliable instrument for assessing chemical attitudes. 2). the results of this study can be empirical data for researchers to conduct further research.

2. RESEARCH METHOD

Instrument of attitude assessment toward chemistry result of content validity based on expert evaluation tested to 245 students consisted of 197 female and 48 male students of Department of Chemistry of Universitas Negeri Semarang (UNNES) in Semarang, Indonesia. According to [15], the sample is very weak when it is 50, weak when it is 100, the medium when it is 200, good when it is 300, very good when it is 500 and perfect when it is 1000. On the other hand, According to [16], the appropriate sample size for factor analysis must be up to 10 times of the variable (item) number. Taking into account all of these views, our sample (N = 200) is the medium level for factor analysis.

In this study the items in the scale adapted from the Test of Science-Related Attitudes (TOSRA) and Attitudes towards Chemistry Lessons Scale (ATCLS). Items that have been compiled, then given to three experts to evaluate the validity of the contents and legibility of the items. Expert validation results obtained 43 items (30 positive and 11 negative statements) are eligible (Table 1). Instruments using Likert scale from 1 = strongly disagree to 5 = strongly agree. Negative sentences were reverse scored. In this study, the width of the class interval is found by dividing the data range of the number of the selected class. Range = highest value - lowest value = 5 - 1 = 4, the class interval = 4/5 = 0.80. Thus, in order to evaluate the findings obtained from the data analysis, the intervals used: 4,21 - 5,00 is strongly agree, 3,41 - 4,20 agree, 2,61 - 3,40 neutral, 1,81 - 2.60 disagree and 1.00 - 1.80 is strongly disagree.

The methodological steps of this research are carried out with the following stages: (1) determining the "attitude toward chemistry" as the variables that the instrument will develop, (2) developing the conceptual and operational definition of the attitude variable to chemistry as a psychological response in the form of feeling or emotion person, (3) formulated points statement to chemicals an assessment instrument is based on a scale of semantic differential, (4) validating the theoretical to the group of expert panelists as judges for the selection of items, (5) the revised instrument, (6) conduct trial. Data obtained through trials are used to test the empirical validity and reliability of the product. (7) Analyzing the items by using factor analysis procedures and *alpha* internal consistency reliability, (8) implements.

The statistical test used is the Measure of Sampling Adequacy (MSA), Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett test of sphericity. Measure of Sampling Adequacy (MSA) is used to determine whether a variable is adequate for further analysis (MSA > 0.5).This value can be seen in the value of anti-image correlation matrix. If the value then the variable is sufficient to be analyzed further. If an MSA value of the initial variables less than 0.5 must be excluded from the analysis, it is sorted from the variable whose MSA value is the smallest and is not used anymore.

Exploratory factor analysis was used to find out if the sub-scales identified by others [10] were present in the cohort of pre-service teacher students. The internal structure of all data was assessed using the principal axis factoring method with varimax rotation [17], Confirmatory Factor Analysis through the analysis of the Maximum Likelihood (ML) method. Internal consistencies of items loading into each identified sub-scale were estimated using Cronbach's. All the process of factor analysis was using SPSS for Windows Version 20.0

3. RESULTS AND ANALYSIS

3.1. Results

The results of the preliminary stage showed the Kaiser Meyer Olkin Measure of Sampling Adequacy (KMO MSA) as shown in Table 1.

Table 1. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.824
Bartlett's Test of Sphericity	Approx. Chi-Square	3837.634
	Df	903
	Sig.	.000

Table 1 provides information on two factor analysis assumptions. The results of the preliminary stage showed the Kaiser Meyer Olkin Measure of Sampling Adequacy (KMO MSA) of 0.824 with a significance of 0.000. The Bartlett Test ($p < 0.001$) showed that the correlation coefficients all zero and KMO> 0.70 indicates that the sample data suitable for factor analysis (Hair, Anderson, Tatham, & Black, 2006), which means good and significant. According to the criteria [13] from Bartleet test for test of sphericity also obtained Chi Square of 3837, 634 with a degree of freedom 903 in the significant of 0,000, which means that the correlation matrix is not an identity matrix so that it can be used a factor analysis.

Results of anti image correlation (AIC) can not be found with the test item MSA rates below 0.50 so for the next process all test items included again in the analysis. Furthermore, of the 43 items were included in the analysis root characteristic values obtained factor *(eigen values> 1)* in the table total variance explained) and the results display scree plot shows the high arched reduction was observed after twelve factors. From this, it can be said that the scale has twelve factors [18].

From the Total Variance Explained used to confirm the validity of the construct, obtained the twelve construction factors that consisted of 43 items are able to explain 63.472% of the total variant. Thus it can be concluded that the instrument attitude assessment on chemistry developed is valid in terms of construct validity. In addition to the factor charge variance that can explain the variance of attitudes toward chemistry, the cumulative charge of the twelve factors is 63.472% variance.

In rotated matrix component, it is showing no item passing through the charge factor *"cut off point"* < 0.30. The largest factor loads are in item 42 of 0.829 and the smallest point 12 is 0.324. Thus all statements are valid, but for items 27,25,33,12,23,32,20 and 31 are not included in the further analysis because of the factor load <0.5. After the release of 8 items make the number of items remaining as many as 35 items. The results of computation after the thirty-five items in the re-analysis produced KMO and Barttlett's Test as shown in Table 2.

Table 2. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.800
Bartlett's Test of Sphericity	Approx. Chi-Square	2812.016
	Df	595
	Sig.	.000

From Table 2 the value of KMO MSA is 0.800. This value is a test of analytical requirements included in either category. This means exact factor analysis to analyze data in the form of correlation matrices. Results of Bartlett's test indicated the test of Sphericity of 2812.016 on 595 degrees of freedom with a significant level of 0000 is very good. Thus the correlation matrix formed is not the identity matrix, so factor analysis can proceed. Furthermore, of the 35 items were included in the analysis root characteristic values obtained factor *(Eigen values> 1)* in the table and the total variance explained scree plot display results as shown in Table 3 and Figure 1.

Table 3. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.018	20.050	20.050	7.018	20.050	20.050	3.012	8.605	8.605
2	2.754	7.868	27.919	2.754	7.868	27.919	2.617	7.478	16.083
3	2.243	6.408	34.327	2.243	6.408	34.327	2.467	7.050	23.132
4	2.076	5.932	40.258	2.076	5.932	40.258	2.375	6.786	29.918
5	1.485	4.243	44.502	1.485	4.243	44.502	2.263	6.465	36.383
6	1.411	4.032	48.533	1.411	4.032	48.533	2.202	6.291	42.674
7	1.382	3.949	52.482	1.382	3.949	52.482	2.175	6.213	48.887
8	1.228	3.509	55.990	1.228	3.509	55.990	1.776	5.074	53.961
9	1.120	3.200	59.191	1.120	3.200	59.191	1.565	4.471	58.432
10	1.020	2.914	62.105	1.020	2.914	62.105	1.285	3.673	62.105
11	.978	2.795	64.900						
12	.930	2.658	67.558						
13	.880	2.515	70.073						
14	.860	2.458	72.531						
15	.766	2.189	74.720						
16	.757	2.163	76.884						
17	.707	2.019	78.903						
18	.644	1.841	80.744						
19	.619	1.767	82.511						
20	.564	1.611	84.122						
21	.553	1.581	85.703						
22	.537	1.536	87.239						
23	.476	1.360	88.599						
24	.458	1.308	89.907						
25	.435	1.242	91.149						
26	.428	1.223	92.371						
27	.385	1.100	93.472						
28	.372	1.063	94.534						
29	.346	.989	95.524						
30	.318	.910	96.434						
31	.302	.864	97.298						
32	.268	.766	98.064						
33	.258	.737	98.801						
34	.223	.637	99.438						
35	.197	.562	100.000						

Extraction Method: Principal Component Analysis.

In Table 3, the total explained variance of 35 points was put into the factor analysis showed that the number of factors attitudes toward chemistry is 10, according to many indicators estimated. Thus it can be said that the instrument of attitude assessment of chemistry is valid in view of the validity of the construct. In addition to the factor charge variance that can explain the attitude toward chemistry, cumulatively the ten factors are equal to 62.105% variance.

Figure 1 shows display of scree plot is the explanation for total variance explained tables in graphic form. *Scree plot* diagram shows how the downward trend Eigen value that is used to subjectively determine the number of factors used.

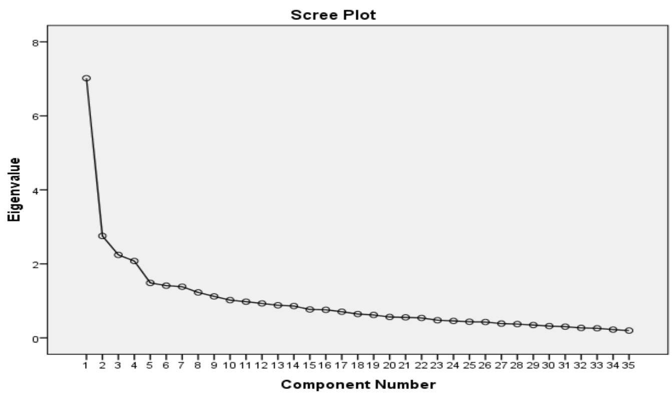

Figure 1. *Scree plot* diagram

In Table 4 of rotated matrix component, it is showing no item passing through the charge factor *"cut off point"* <0.30. The biggest factor loads are in item 42 of 0.827 and the smallest point 9 is 0.438. Thus, all statements are valid. However, for items 9, 26, 40 are excluded from further analysis because the factor load is < 0.5. Thus the number of items in the instrument of attitude evaluation of final chemistry as much as 32 items is valid items in terms of the validity of the construct and has a load factor of > 0.5. In addition to the factor charge variance that can explain the attitude toward chemistry, cumulatively the ten factors are equal to 62.105% variance.

Table 4. Rotated Component Matrix[a]

	Component									
	1	2	3	4	5	6	7	8	9	10
VAR00015	.738									
VAR00016	.645									
VAR00006	.613									
VAR00008	.607									
VAR00014	.595									
VAR00009	-.481		.438							
VAR00042		.827								
VAR00043		.809								
VAR00041		.653								
VAR00039		.501			.320	.303				
VAR00010			.702							
VAR00011			.629							
VAR00005			.531			.388				
VAR00024			.517						-.455	
VAR00021			.507				.345		-.366	
VAR00013	-.420		.500							
VAR00003				.828						
VAR00002				.822						
VAR00004				.668						.373
VAR00001				.618						
VAR00029					.817					
VAR00028					.665					
VAR00030					.611					
VAR00037						.767				
VAR00038						.765				
VAR00040		.438			.306	.498				
VAR00018							.743			
VAR00019							.727			
VAR00017							.726			
VAR00034								.748		
VAR00036								.683		
VAR00035								.620	-.314	
VAR00022									.694	
VAR00026	.384					-.317			.440	
VAR00007										.832

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 12 iterations.

Each factor is named according to the construct described by the item. The factor name considers the charge and statement sounds on each item that describes the constituent aspects. It turns out that after the distribution of factor loads, item 7 on the tenth factor has the same name with the first factor, so item 7 is entered into the first factor. The distribution of the grading instrument on chemical assessment to 9 factors is presented in Table 5.

Table 5. The distribution of the grading instrument on chemical assessment

Distribution of item	Factor	Nama Faktor
Q6,Q7,Q8. Q14, Q15, Q16	1	Difficulties in concept applications
Q39, Q41, Q42, Q43	2	The importance of studying chemistry for life
Q5, Q10, Q11, Q13, Q21, Q24	3	interest in learning concepts
Q1, Q2, Q3, Q4	4	Difficulty in understanding the concepts
Q28, Q29, Q30	5	The importance of studying chemistry for life
Q37,Q38	6	Chemistry has an effect on life
Q17, Q18, Q19	7	Interest in experimentation
Q34, Q35, Q 36	8	Chemical relation with technology and life
Q22	9	Chemical interest to solve problem.

The first factor relates to "Difficulties in concept applications." The items under this factor are related to the difficulties of the students on the application of chemical concepts in everyday life. This factor consists of 5 items with a load between 0.595 and 0.738 and Explains 20.1% of the total variant. One example of the statement in factor 1 is, "I am not able to interpret the world around me using chemical knowledge".

The statement of the second factor is related to "The importance of studying chemistry for life". Factor 2 consists of 4 items. The loadings factor of the items listed under this factor ranges from 0.501 to 0.827 explains 7.9% of the total variant. Two examples of the statements under factor 2 are: "Chemistry is useful for solving problems in everyday life" and "Chemistry is our hope to solve various environmental problems". The third factor is related to "Interest in learning the concept of chemistry". Factor 3 consists of 6 items. The loadings factor of the items listed below this factor ranges from 0.500 to 0.702 explains 6.4% of the total variant. Three examples of the statements in factor 3 are; "The chemistry lessons are my favorite subjects.", "I want to get more chemistry lessons", and "chemistry lesson is a very interesting subject".

Maximum likelihood estimation methods were used and the input for each analysis was the covariance matrix of the items. Computation with maximum probability confirmatory method (ML) in the first test, obtained the suitability of goodness of test of 0.90, as well as the maximum probability (ML) in the second test obtained the suitability of goodness of fit test of 0.91 which indicates the fit model or models to be accepted which means very significant. The goodness-of-fit of the models was evaluated using the absolute goodness-of-fit indices. The results of data processing analysis shows that the construct is used to establish a research model, the confirmatory factor analysis process has met the goodness of fit criteria that have been set. Probability value of goodness of fit test showed the value of 0.00 (<0.05), and RMSEA 0.052 (< 0:08). Fit indices generated by the LISREL program Showed that the models fitted well the Minimum Data Fit Function Chi-Square = 282.54 (P = 0.00). Following Marsh, Balla, and Hau (1996) & (Hoyle, 1995) in (Schaufeli & Bakker, 2004), three relative goodness-of-fit measures were calculated: (1) normed Fit Index (NFI); (2) Non-Normed Fit Index (NNFI); and (3) Comparative Fit Index (CFI). For all three indices are relatively fit, as a rule of thumb, values greater than 0.90 are considered as indicating a good fit. Results of compatibility tests normed Fit Index (NFI) = 0.91, Non-normed Fit Index (NNFI) = 0.91 and Comparative Fit Index (CFI) = 0.91 so the model has been declared fit.

Testing of internal consistency of alpha reliability coefficient in the first and the second tests shows the coefficient values increase. The reliability of the scale in the first trial was α = 0.86, obtained from the sub-scale reliability coefficients of 0.90; 0.91; 0.82 and 0.81. The reliability coefficient in the second test of 0.91 obtained from the sub-scale coefficient of 0.92 each; 0.94; 0.88 and 0.90. The Cronbach alpha coefficient for the whole scale is found at 0.91 for the 32 items. Nunnally stated a very dependable scale if Cronbach Alpha is ≥ 0.80, α < 1.00. Spooren et al. [19] asserted that the Cronbach alpha value above 0.70 is sufficient George and Mallery [20] declared that Alpha values greater than 0.9 is excellent and greater than 0.8 is good. Therefore, it can be said that items on a scale developed are reliable measurement tools.

3.2. Discussion

Validity testing is conducted to determine whether the measuring tool used in this study really measure what to be measured. In this research has done two stages of validity test, that is content validity and construct validity. In this research for content validity conducted through focus group discussions with expert's evaluation chemical education and literacy experts in one teacher education in Central Java. The validity of constructs aims to find out the extent to which the measurement scores can illustrate the theoretical constructs underlying the measuring instrument. For the fulfillment of this construct validity factor analysis has been done to test whether the item or indicator items used can confirm a factor or construct or variable. Technically this is conducted by co-varying all variables observed (manifest or observed variables). Factor analysis gives the best item description. The best items converge on a factor. Items that have a high correlation with one factor have a low correlation with other factors. Factor analysis provides confirmation of the ten factors that make up the scale. Items that highly correlate with one factor become the final item.

Based on the factor analysis on the first test used the exploratory method, which initially extraction shows there are as many as 12 factors. The extraction of all the factors obtained by item of statement as much as 43 items. Of the twelve such factors gave the percentage of total variance 63, 472%. All loading factor are worth over 0.30. Computing with maximum probability confirmatory method (ML) obtained suitability test of 0.90 goodness of fit model or models indicate acceptable. Testing by factor analysis on the second test using confirmatory method, initially extraction showed there were as many as 10 factors. The result of 10 factor extraction was obtained after the item statement was issued as many as 8 items. The results of the extraction gave the cumulative variance of the ten factors of 62.105%. Computing with Maximum Likelihood obtained suitability goodness of fit test of 0.91 indicates a fit model or models to be accepted, which means very significant. However, after the factor charge is distributed, there is an item on the tenth factor that has the same name as the first factor, so that the item is inserted into the first factor. Thus, the distribution of the assessment items on chemical assessment becomes 9 factors.

Given the data obtained from a sample of prospective chemistry teacher students in one of the teacher education, this study provides evidence for the reliability and validity of the attitude scale on chemistry. In line with what has been discovered by [21], found that the scale of attitudes toward chemistry developed, in both testing has produced test requirements analysis with Kaiser Meyer-Olkin about the measure of sampling adequacy (KMO MSA) respectively 0.824 and 0.800 which belong to the Category is very good. Something similar to Bartlett's test for test of sphericity, with degrees of freedom df = 903 and a significance level of 0,000 on the first attempt, and with degrees of freedom df = 595 and a significance level of 0.000 at the second trial. Computing with maximum probability confirmatory method (ML) obtained suitability of the goodness of a test of 0.90 in the first test indicates a fit model or models to be accepted, as well as in the second test obtained goodness of a test of 0.91.

The developed attitude scale also shows good internal consistency reliability, as above the suggested threshold of 0.91 in the trial. Internal consistency reliability of 0.80 has shown good reliability [19],[20],[22]. The intercorrelation of all factors after item exclusion at the low factor and EFA correlation stages yielded eleven items that were killed. This shows that the thirty-two items of attitude scale developed meet the valid and reliable criteria.

For practical applications, this scale can be used as an instrument in educational research. Scale can help in determining the specialization in high school. In fact, the scale can give information what majors should be taken in the continuation of their studies. With the availability of this attitude scale, chemistry teachers can know students' attitudes to learning in order to optimize academic achievement, because the attitude of students towards subjects is the biggest predictors in the prediction of success in learning. By knowing early on the attitude of students to the lesson, there are various steps that can be done in optimizing the success of learning.

4. CONCLUSION

Based on the examination of the validity of constructs using factor analysis and internal consistency/reliability on the scale developed, it can be concluded that 32 items of statements on the instrument of assessing attitudes toward chemicals significantly contribute to the indicator. From Table 6 it can be seen that in two experimental tests conceptually 9 factors are fewer than theoretically estimated, namely: (1) Difficulties in the application of concepts, (2) the importance of studying chemistry for life, (3) interest in learning concepts, 4) Difficulty in understanding the concepts, (5) The importance of studying chemistry for life, (6) Chemistry has an effect on life, (7) Interest in experimentation, (8) Chemical relation with technology and life, and (9) Chemical interest to solve problem.

The scale developed in this study can be used by researchers in experimental and descriptive studies. However, since my research has only been done in one teacher education, I plan to conduct further research to test the reliability and validity of the constructs of the attitude scale at other teacher educations. Hopefully, the scale of attitudes toward chemistry that has been developed can serve as a useful tool for other science teachers to gather information about their students' attitudes toward the subject especially at the beginning and end of the school year.

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