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Chemistry Learning Anxiety Scale: A Scale Development

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ABSTRACT
The main purpose of the study was to develop the Chemistry Learning Anxiety Scale (CLAS) instrument. The method used this study is the survey method. Data of chemistry learning anxiety was obtained through a questionnaire. There are three aspects of the chemistry learning anxiety scale that were examined in this study, Anxiety in Study Chemistry, Anxiety in Finishing Chemistry Tasks, and Anxiety in Doing Practicum. The content validity of the CLAS instrument with 48 items that had been administered to 115 student's 11th senior high school. The data were analyzed using the Rasch model that have been 5 criteria, namely unidimensionality, item fit, difficult/ability estimation, reliable, and information function. The conclusion of the Rasch model showed that there are 46 items CLAS that fit model and excellent reliable for the person's reliable and excellent reliable for the item reliable. The CLAS instrument is a good instrument to collect the data.

Keywords: *Chemistry learning anxiety scale, Anxiety in study chemistry, Anxiety in finishing chemistry, Anxiety in doing practicum*

1. INTRODUCTION

Chemistry is a branch of science, as said by [1] science is a body of knowledge which means it is the center of all knowledge. Besides, chemistry is one of the important subjects in high school and is closely dependent on various disciplines, such as pharmacy, medicine, technology, chemical technology, textile technology, and so on. However, most students consider chemistry to be a very difficult subject to answer and understand. This is consistent with research conducted by [2] that chemistry is an abstract subject, full of scientific concepts and students find it difficult to connect between microscopic and macroscopic chemistry [3]. Research conducted by [4] states that the factors that cause chemistry are difficult to do based on numeracy skills, classes that are too crowded, students' language skills in understanding chemistry, and teaching skills in teaching. As a result, students have a negative perspective on chemistry.

A student who has a negative perspective on chemistry will feel bored, anxious [5], afraid and insecure during the learning process [6] so that events of stress, worry, as excessive fear, and anxiety when studying chemistry are also called study chemistry. Packaging according to [7] is the basic emotion that a person has that happens at one time and is worried about something that is not certain to happen. However, a crisis is a feeling that someone does not want because it will interfere with the scientific process within a person [8].

Chemistry learning anxiety is caused by several factors expressed by [9] namely: the anxiety of learning chemistry when solving mathematical problems, tests, or evaluations, chemistry teachers who teach do not understand chemical content, work in chemical laboratories, and students' negative perceptions. when you hear the word "chemistry". Based on research conducted by [10] - [13] stated the anxiety of learning chemistry caused by three factors namely: studying chemistry, evaluating chemistry, and handling chemicals. [14] states the basic cause of anxiety when studying chemistry is the broad scope of the syllabus, low awareness of career opportunities in chemistry, lack of work visits to the field, incomplete laboratory equipment, and poor

teaching methods. Based on the results of the research that has been done, the evaluation of chemistry learning hurts students, such as decreased academic achievement and academic performance, students' learning in receiving chemistry lessons [11] decreased learning motivation [4] and students cannot think clearly [15]. The chemistry learning instrument was first developed by [9] which aims to reduce chemistry learning consists of 6 items. Subsequently, [10] developed Chemistry learning anxiety consists of 36 items and is divided into 3 aspects, namely; learning, evaluation, and practicum. Meanwhile, this article aims to develop students' chemistry learning instruments.

2. RESEARCH METHODS

This study used a survey method. The sample involved was 11th Senior High School, SMA Negeri 1 Godean, Yogyakarta, Indonesia.

2.1. Development of Chemistry Learning Anxiety

The instrument used in this study was developed based on the elaboration and adaptation of several researchers [5], [9], [10], [14], [15]. To confirm the validity of the content, the researchers outlined a framework theory about the chemistry learning anxiety scale as a basis for building items and ascertaining it to experts. The statements of the instrument are developed appropriately for students and then translated into Indonesian.

There are three dimensions of chemistry learning anxiety scale that were examined in this study, anxiety in study chemistry, anxiety in finishing chemistry tasks, and anxiety in doing a practicum. The response scale for the Chemistry Learning Anxiety Scale (CLAS) ranges from “High anxiety = 5” to “No Anxiety = 1”. Besides theoretical validity is done by asking for improvement in terms of language in the form of an assessment of the items of the instrument to two experts’ lecturer from the Department of Chemistry Education. Empirical validity was done by giving questionnaires to 115 students.

2.2. Data Analysis

The results of validate the instrument and measure its reliability using the Rasch model by Winstep program. There are five characteristics for the analysis of instrument by unidimensionality, item fit, difficult/ability estimation, reliable, and information function.

3. RESULT AND DISCUSSION

3.1. Unidimensionality

The unidimensional assumption test aims to measure the items of a test measuring only one ability [16]. The unidimensional assumption test of an instrument can be done with factor analysis, namely Confirmatory factor analysis (CFA) which aims to identify whether the indicators used are the constructs of the research variables used or whether these indicators are unitary or unidimensional.

Furthermore, to ascertain whether a data is suitable or feasible can be done by confirmatory factor analysis, it is necessary to analyze the adequacy of the sample (data) by taking into account the KMO (Kaiser-Meyer-Olkin) value and the Barlett value. The accepted value requirements for factor analysis are > 0.6 for the KMO value (Kaiser-Meyer-Olkin) and Barlett's Test significance value which is smaller than 0.5 [17].

Table 1. KMO-MSA and barlettsphericity test results

The Test	Chemistry Learning Anxiety Scale	Result for Factor Analysis
KMO-MSA	0.780	Appropriate
The significant value of Barlett-sphericity test	0.000	Appropriate

The results from Table 1 show that, the output value of KMO-MSA and Barlettsphericity test is used to determine the feasibility of a variable. As for the criteria for the KMO-MSA value, if the KMO-MSA value is greater than 0,5 then the factor analysis can be continued. Based on the output Table 1, the KMO-MSA value is 0.780, and Barlett’s test of sphericity (sig) 0,000 < 0,05, then the factor analysis on unidimensionality or construct validity. Further analysis to test unidimensional assumptions is to test the eigenvalues of the inter-grain covariance variance matrix. This assumption is fulfilled if the percentage value of the matrix eigenvalues is more than 20% of the variance [18] or the total value obtained is greater than 1 [19]. The eigenvalues for the chemistry learning anxiety instrument are shown in Table 2.

Table 2 shows that the chemistry learning anxiety scale instrument can contain 13 eigenvalues which have a total eigenvalue greater than 1. These results indicate that there are 13 factors formed that can explain 70,824 variances.

Table 2. Total variance explained by the result of factor analysis

Factor	Initian Eigen Value			Factor	Initian Eigen Value		
	Total	% of Variance	Cumulative		Total	% of Variance	Cumulative
1	12.766	26.596	26.596	25	0.481	1.002	88.481
2	4.189	8.726	35.323	26	0.476	0.991	89.472
3	2.539	5.290	40.613	27	0.424	0.882	90.354
4	2.042	4.254	44.867	28	0.416	0.886	91.220
5	1.780	3.708	48.575	29	0.383	0.798	92.018
6	1.695	3.531	52.106	30	0.380	0.792	92.810
7	1.586	3.304	55.410	31	0.361	0.751	93.561
8	1.397	2.911	58.321	32	0.350	0.728	94.289
9	1.362	2.837	61.159	33	0.314	0.654	94.943
10	1.231	2.566	63.724	34	0.275	0.573	95.516
11	1.210	2.521	66.245	35	0.268	0.559	96.075
12	1.132	2.359	68.604	36	0.231	0.481	96.556
13	1.066	2.220	70.824	37	0.224	0.467	97.023
14	0.963	2.006	72.830	38	0.218	0.454	97.447
15	0.953	1.985	74.815	39	0.191	0.397	97.874
16	0.842	1.754	76.569	40	0.177	0.368	98.242
17	0.801	1.669	78.238	41	0.159	0.331	98.573
18	0.758	1.580	79.818	42	0.132	0.274	98.874
19	0.698	1.454	81.272	43	0.122	0.254	99.101
20	0.661	1.376	82.649	44	0.115	0.239	99.340
21	0.632	1.317	83.966	45	0.095	0.198	99.538
22	0.626	1.305	85.271	46	0.078	0.162	99.701
23	0.546	1.138	86.409	47	0.074	0.153	99.854
24	0.513	1.070	87.479	48	0.070	0.146	100.000

The results of the factor analysis can also be seen through a scree plot that visualizes the eigenvalue with the number of components that can be maintained as a factor. The graph on the screen plot aims to visually describe the number of factors that are formed. Meanwhile, the scree plot of the total eigenvalues for the chemistry learning anxiety instrument can be seen in Figure 1. Based on Figure 1, the scree plot can be observed that the relative curve starts to slope at factor 15.

This shows that there are 13 factors formed where the first factor can explain the variance of more than 26.596%, so the assumption unidimensional has been met [18]. The results of the local independence assumption test were carried out to complete a matrix divided into high to low levels using a variance-covariance matrix. In Table 3, shows that the covariance value of the participants shows 0.00 so that local independence can be fulfilled [20]. The zero value indicates that chemistry learning anxiety scores in answering one item do not affect the chemistry report in answering other items.

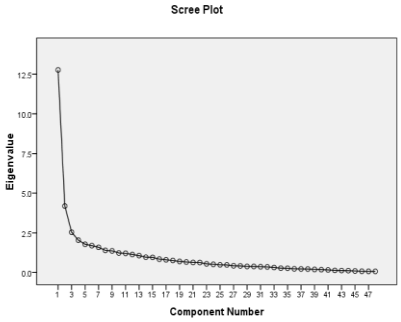

Figure 1 Scree plot of CFA in unidimensionality

Table 3. Covariance matrix of chemistry learning anxiety scale

Columns	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	0.026 893									
C2	0.010 54	0.004 498								
C3	0.010 473	0.004 2	0.004 582							
C4	0.008	0.003	0.003	0.0033						

	615	593	355	16						
C5	0.005 114	0.002 001	0.001 991	0.0015 54	0.0010 51					
C6	0.007 612	0.003 034	0.003 164	0.0026 12	0.0014 46	0.0024 07				
C7	0.011 079	0.004 577	0.004 5	0.0034 41	0.0021 29	0.0030 68	0.0052 99			
C8	0.019 275	0.007 905	0.007 773	0.0056 77	0.0038 71	0.0051 78	0.0088 37	0.0162 81		
C9	0.033 622	0.013 863	0.013 745	0.0120 28	0.0062 12	0.0100 72	0.0140 53	0.0236 74	0.0459 6	
C10	0.076 7	0.025 961	0.044 183	0.0104 83	0.0122 22	0.0165 94	0.0411 5	0.0715 11	0.0812 33	0.9276 22

3.2. Item Fit

In the Rasch model concept, items that can be used to see the quality of an instrument are sufficient. Item analysis is used to see an item that can function normally in taking measurements or not. The item said is said to be valid, if it meets the requirements for data collection, at least 2 criteria. The criterion values used to check the suitability of the items were: (a) Means-square outfit value: 0.5 < Means-square < 1.5; (b) Z-standard Outfit value: -2.0 < Z-standard < +2.0; (c) Point-Measure Correlation value: 0.4 < Point- measure correlation < 0.85 [21].

3.3. Difficult/ Ability Estimation

The level of difficult/ ability estimation is used to see the ability of participants to answer items correctly. Difficult level/ ability estimation criteria based on [19] if values of b (item measure) ≤ -1 indicate very easy; indicate easy -.5 ≤ b < -1; indicate medium -.5 ≤ b < .5; < 1 indicate a very difficult; .5 ≤ b < 1 indicate difficult; and b > 1 indicate very difficult.

Based on Table 4, all items that have been analyzed using the winstep program, 2 items are not fit, namely items 19 and 46. The result of the analysis showed 46 items are fitted with the PCM-1PL model can be used for the analysis of measuring chemistry learning anxiety students.

Table 4. The results of the fit measurement instrument test

Item	Means-square Outfit	Z-standard Outfit	Point-Measure Correlation	Result	Item	Means-square Outfit	Z-standard Outfit	Point-Measure Correlation	Result
29	1.79	3.7	0.39	Not fit	14	1.05	0.4	0.38	Fit
46	1.69	2.4	0.31	Not fit	12	0.96	-0.2	0.51	Fit
28	1.29	1.3	0.41	Fit	21	0.94	-0.3	0.51	Fit
1	1.19	1.0	0.42	Fit	40	0.99	0.0	0.55	Fit
37	0.89	-0.1	0.22	Fit	34	0.98	-0.1	0.58	Fit
30	1.29	1.8	0.39	Fit	19	0.97	-0.1	0.44	Fit
36	1.26	1.6	0.38	Fit	2	0.90	-0.5	0.49	Fit
24	1.26	1.8	0.53	Fit	31	0.98	0.0	0.46	Fit
32	1.26	1.3	0.34	Fit	38	0.99	0.0	0.54	Fit
20	1.21	1.6	0.52	Fit	41	0.98	-0.1	0.44	Fit
10	1.21	1.4	0.53	Fit	26	0.92	-0.6	0.57	Fit
35	1.17	1.3	0.44	Fit	11	0.93	-0.4	0.54	Fit
25	1.12	0.9	0.56	Fit	47	0.91	-0.6	0.54	Fit
23	1.11	0.9	0.56	Fit	22	0.89	-0.8	0.63	Fit
42	1.09	0.5	0.37	Fit	27	0.87	-0.9	0.49	Fit
13	1.06	0.4	0.41	Fit	6	0.78	-1.2	0.56	Fit
33	1.10	0.5	0.38	Fit	15	0.80	-1.0	0.47	Fit
16	1.07	0.5	0.47	Fit	5	0.74	-1.5	0.53	Fit
39	1.04	0.3	0.40	Fit	45	0.66	-1.1	0.36	Fit
4	1.09	0.5	0.39	Fit	18	0.78	-1.6	0.55	Fit
48	0.95	-0.2	0.54	Fit	9	0.77	-1.8	0.61	Fit
44	1.07	0.4	0.35	Fit	3	0.67	-2.4	0.61	Fit
43	1.08	0.4	0.32	Fit	17	0.69	-2.0	0.50	Fit
8	1.08	0.6	0.54	Fit	7	0.62	-2.5	0.59	Fit

Table 5. The results of item difficult of chemistry learning anxiety.

Item	Difficult index	Category	Item	Difficult index	Category
41	-1.01	Very easy	21	0.26	Medium
24	-1.07	Very easy	48	0.24	Medium
22	-1.17	Very easy	13	0.22	Medium
26	-1.17	Very easy	17	0.22	Medium
35	-1.37	Very easy	12	0.08	Medium
40	-1.43	Very easy	36	-0.07	Medium
20	-1.75	Very easy	47	-0.25	Medium
23	-2.33	Very easy	16	-0.36	Medium
10	-0.61	Easy	30	-0.36	Medium
38	-0.72	Easy	3	-0.37	Medium
27	-0.73	Easy	28	0.94	Difficult
18	-0.76	Easy	33	0.78	Difficult
11	-0.77	Easy	39	0.74	Difficult
8	-0.83	Easy	15	0.72	Difficult
25	-0.83	Easy	32	0.72	Difficult
34	-0.89	Easy	31	0.62	Difficult
9	-0.96	Easy	1	0.54	Difficult
19	0.48	Medium	2	0.54	Difficult
4	0.45	Medium	37	3.14	Very difficult
6	0.45	Medium	45	2.21	Very difficult
14	0.41	Medium	44	1.45	Very difficult
5	0.39	Medium	46	1.24	Very difficult
7	0.34	Medium	43	1.21	Very difficult
29	0.29	Medium	42	1.13	Very difficult

3.4. Reliable

The reliability of an instrument is used to determine whether an item on a device is spread out along a continuum. Reliability results can be seen by paying attention to the Alpha Cronbach value.

According to [22] that the closer Cronbach's alpha coefficient is to 1.0 the greater the internal consistency of the items in the scale. Meanwhile, criteria of Alpha Cronbach value based on [23], if > 0.9 indicates excellent; > 0.8 indicates good; > 0.7 indicates acceptable; > 0.6 indicates questionable; > 0.5 indicates poor and < 0.5 indicates unacceptable.

Table 6. Statistics of person and item reliable

	Infit		Outfit				
Parameter (N)	Mean-square	Z-standard	Mean-square	Z-standard	Separation	Reliable	Category
Person(115)	1.02	-0.2	1.02	-0.1	3.85	0.94	Excellent
Items (46)	1.03	0.2	1.02	0.1	6.95	0.98	Excellent

Based on Table 6, the instrument reliable was analyzed according to the person and item analysis. The person reliable value is found 0.94, indicating excellent reliable with a 3.85 separation index while the item reliable value is found 0.98, indicating excellent reliable with a 6.95separation index.

The initial CLAS consists of 46 items that contain the three aspects. The number of items on each CLAS was well distributed on 13 items on anxiety in the study chemistry aspect, 13 items on anxiety in finishing of chemistry tasks aspect, and 22 items on doing a practicum. The reliable of the person and item is found in the excellent category. The item difficult was well distributed on a very easy, easy, medium, difficult, and very difficult category.

3.5. Information Function

Information function is a method used to describe an item suitable for measuring the estimated level of ability [24]. Function information is also used to describe the reliable coefficient of the overall test item. Figure 2 showed that the maximum IF value of the CLAS instrument with 48 items found to be 1.071. The function information graph showed that 0.2 and 0.4 which means the statement used produces high information on individuals with a high ability or showed statement with high difficulty.

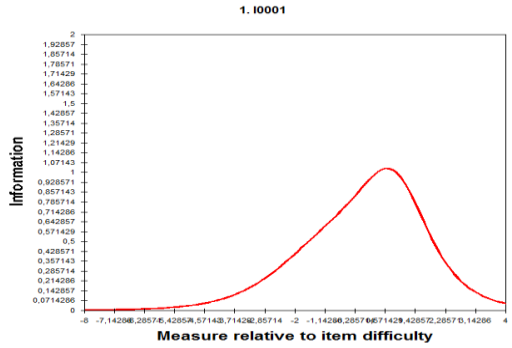

Figure 2 Test information for CLAS

4. CONCLUSION

The result of this study showed that CLAS instrument has construct validity. This suggests that the CLAS instrument is the potential to be a useful instrument for researchers and chemistry teachers for measuring the chemistry learning anxiety of students.

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