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Development of Attitude Assessment Instruments Towards Socio-Scientific Issues in Chemistry Learning

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Abstract: A socio-scientific issue is one of the learning techniques used today, which uses various scientific sources to make students think scientifically to conduct a dialogue and discuss solving a problem. Various problems in socio-scientific are controversial, requiring reasoning, and ethical evaluation in the decision-making process. A conflict between chemical reason and students' social point of view will cause students' different assessments and attitudes towards the socio-scientific issue. This study is a research and development (R&D) that focuses on the instrument's validity with the factor analysis technique to assess attitudes towards the socio-scientific issue in chemistry learning. CFA and EFA analysis found five factors in the tool: anxiety, interests, likes, benefits, confidence, validity, and reliability. The total reliability coefficient is .853. Of the eight instrument feasibility analysis requirements, seven instruments were declared fit to meet construct validity.

Keywords: *Attitude, chemistry learning, factor analysis, socio-scientific issue.*

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Introduction

Attitude is part of the object of assessment of one's mind. Everything that people can think of is the possibility of an attitude, from something very mundane to abstract, either in the form of ideas or ideas of individuals or groups (Bohner & Dickel, 2011). Attitudes can influence the culture of a group and can develop according to habits and circumstances (Roosevelt, 2008). Attitudes are essential because they result from experiences formed over time, shape people's perceptions of the social and physical world, influence friendship and hostility towards others, and give and receive open behaviors (Albarracín et al., 2008; Sharma & Srivastav, 2021).

Attitude is part of the response given by a person in response to a stimulus. Socio-scientific issues are open problems with no clear solution; they may have some plausible explanations. Socio-scientific problems sometimes become global problems, such as environmental crises. These solutions can be informed by scientific principles, theory, and data, but scientific judgment cannot determine them. The problems and potential actions associated with them are influenced by various social factors, including political, economic, and ethical (Sadler, 2011). Socio-scientific issues raise unstructured problems, such as monosodium glutamate (MSG) in food, which involve moral and ethical aspects, and sometimes have no clear solution (Lee & Grace, 2012; Topcu, 2010). Sometimes, topics often used are issues related to science or other social fields (Sadler et al., 2004). According to Zeidler et al. (2005), discussing science-related topics makes students think about how to find scientific solutions to existing problems. The main concern in socio-scientific issues emphasize on ethical and moral issues, so integrated with the scientific process is needed (Sadler et al., 2007). Problems raised by science and society or vice versa with unclear, fragile, ethical, and contradictory evidence and solutions become a reference in studying socio-scientific issues (Sadler, 2004).

Socio-scientific issues raise scientific issues for debate in scientific matters, dialogues, and emerging issues. These structured and unstructured topics have the added element of requiring moral reasoning or evaluating ethical issues but making decisions to solve these problems. Socio-scientific cases are designed to be meaningful and exciting to students, need reason based on scientific evidence, and provide a context for understanding scientific information (Sadler, 2004; Zeidler & Keefer, 2003). Incorporating socio-scientific issues into science learning creates opportunities for students to

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analyze the "point of view" of others, reason critically, suggest participatory decision-making practices, enable critical debate, debate competing scientific claims, and promote character and student issues ' morals to ethics (Eastwood et al., 2012).

Many previous research instruments related to learning socio-scientific issues have been developed, but mainly in the cognitive field of students. Several studies reveal the advantages of socio-scientific issue learning, including social-scientific issue-based teaching, which fosters soft skills and increases environmental awareness (Susilawati et al., 2021). Socio-scientific issue-based learning can improve students' knowledge and practice of discipline (Ke et al., 2020). Socio-scientific issues in the scientific world are fundamental to raising awareness from an early age among chemistry students (Cha et al., 2021). Previous research gave positive results to learning socio-scientific issues, but these positive results were only seen in the cognitive part of students. The researchers need an instrument that can strengthen the positive effects obtained, namely the existence of a tool that can determine perceptions about the implementation of socio-scientific issues that have been carried out so far. To find out students' perceptions, a unique instrument is needed to determine students' attitudes towards learning about socio-scientific issues that have been carried out.

Several socio-scientific attitude instruments have been developed by previous researchers, including Subiantoro and Treagust (2020) developed and validated a tool to assess high school students' perceptions of socio-scientific problem-based learning (SSI) in biology and derive four aspects of learning SSI-based: (1) SSI contextualization, (2) student involvement, (3) student attitudes towards SSI learning and (4) SSI-based learning. This study also examines students' attitudes towards learning using socio-scientific issues, but this study has not thoroughly explained students' attitudes towards learning socio-scientific matters, so an instrument is needed to explain this. In addition, development focuses on biology, while our research focuses on chemistry.

Furthermore, research by Chang et al. (2018) also discusses student attitudes towards socio-scientific; the study's results stated that the philosophy of students after learning using socio-scientific was dominated by perspectives before learning and showed a change in student attitudes. Similar to research by Namdar et al. (2020), attitudes towards socio-scientific issues do not explain informal reasoning. These studies also focus on socio-scientific perspectives in learning but do not discuss and explain the factors of socio-scientific attitudes in question. An attitude instrument is needed to explain the main aspects of attitude in learning socio-scientific issues. Topcu (2010) also states that it is based on an analysis of three factors: interest and use of socio-scientific issues, liking for socio-scientific subjects, and anxiety about socio-scientific issues.Research on the first factor raises many questions because it combines interest and utility in one construct. An attitude assessment instrument is needed that separates attitude and utility in its measurement. In addition, that research focuses on undergraduate students, whereas this research focuses on students.

Based on the study of existing theories and problems, it is necessary to have an attitude instrument for socio-scientific issues that focuses on students and the chemistry field and has factors that are affected by student attitudes such as interests, benefits, preferences, and self-confidence and anxiety about learning chemistry. This research is essential to know students' attitudes toward learning socio-scientific problems, especially chemistry, which, so far, there is no instrument to measure. There are two problem formulations in this study: (1) how to construct attitude assessment instruments for socio-scientific problems in chemistry learning; (2) is the attitude assessment instrument for socio-scientific problems in chemistry learning valid and reliable. This study aims to develop a valid and reliable instrument for assessing student attitudes towards socio-scientific problems in chemistry learning.

Methodology

Research Design

This study developed an instrument to assess attitudes towards socio-scientific problems in chemistry learning. This instrument was developed based on theoretical analysis and obtained eight indicators developed in 28 items. The indicators developed include interest, benefit, liking, self-confidence, anxiety, culture, diversity, and religion in studying socio-scientific problems in chemistry. The instrument's content validity used content validity ratio (CVR), and the construct used factor analysis techniques.

Sample and Data Collection

In the content validation analysis using CVR, 10 participants were involved as material experts, education experts, chemists, and practitioners. After getting a valid instrument based on the CVR, the next step is to collect data directly from the respondents. Respondents involved in this study were high school students in Indonesia, especially in South Sulawesi Province. The characteristics of respondents involved in this research are students who have studied socio-scientific problems in chemistry learning. The sample selection technique was carried out using a random sampling technique. This study has two samples: the first sample consisted of 250 students comprising 109 male and 141 female students. The second sample also consisted of 250 selected students, consisting of 83 male and 167 female students. The selection was chosen and then filled out a questionnaire that had been developed, which consisted of factors of interest, benefit, liking, self-confidence, and anxiety about learning chemistry. The filled-out questionnaire asks students to choose an answer for the things they feel in studying socio-scientific issues, which consist of; strongly disagree, disagree, neutral, agree, and strongly agree. The first sample is for exploratory factor analysis (EFA), and the second is for confirmatory factor analysis (CFA).

Analyzing of Data

The process of developing attitude instruments is carried out through theoretical studies. The results of the academic research obtained several factors that were per the analysis of socio-scientific issues. The next step is to determine the item for each element by adjusting it with the relevant theory. The results of further development are analyzed using content validation and factor analysis. Content validation analysis uses the CVR technique. This study used ten panelists with the appropriate minimum CVR value for ten panelists was .62 (Lawshe, 1975). Factor analysis in this study used two methods: EFA and CFA. EFA and CFA can be directly applied to instrument development (Mvududu & Sink, 2013). EFA is a factor analysis method to identify the relationship between manifest or indicator variables in building a construct. The main criteria for EFA are Kaiser-Meyer Olkin Measure (KMO) > .50 (Yong & Pearce, 2013) and communalities between .60 and .80 (Goretzko et al., 2021). At the same time, CFA is used to test whether the indicators that have been grouped based on their latent variables (constructs) are consistent in the construct. The main criteria for CFA are loading factor ≥ .05, RMSEA ≤ .08, GFI, and CFI ≥ .09 (Mustafa et al., 2020).

Findings / Results

The primary objective of this research is to develop an assessment instrument for socio-scientific problems in chemistry learning. Setting an attitude assessment in socio-scientific issues is done by determining the relationship between variables and indicators, testing the resulting indicators, and the consistency of their constructs. The results and stages of the research are described as follows:

Content Validity Ratio (CVR)

The CVR statistics formulated by Lawshe (1975) reflects items' content validity level based on empirical data. Implementation of CVR by forming a panel of experts (Content Evaluation Panel) with diverse expertise to assess items in the instrument. Each expert estimates whether the item is categorized as essential, helpful but not essential, or not needed (Mardapi, 2017). This study uses 10 Subject Matter Experts, education experts, chemists, and practitioners. According to Lawshe, the minimum CVR value suitable for ten panelists is .62. Table 1 shows the CVR calculation results.

Table 1. Validation Calculation Using Lawshe's CVR Index

Items	Value			Total SME	CVR Value	Information
	Essential	Useful not essential	Not required			
1	9	1	0	10	.80	Good
2	9	1	0	10	.80	Good
3	9	0	1	10	.80	Good
4	5	4	1	10	.00	Not good
5	9	1	0	10	.80	Good
6	9	1	0	10	.80	Good
7	4	3	3	10	-.20	Not good
8	9	1	0	10	.80	Good
9	9	1	0	10	.80	Good
10	9	0	1	10	.80	Good
11	9	1	0	10	.80	Good
12	6	2	2	10	.20	Not good
13	9	1	0	10	.80	Good
14	7	1	2	10	.40	Not good
15	7	3	0	10	.40	Not good
16	9	1	0	10	.80	Good
17	9	0	1	10	.80	Good
18	6	4	0	10	.20	Not good
19	6	3	1	10	.20	Not good
20	7	3	0	10	.40	Not good
21	5	2	3	10	.00	Not good
22	9	1	0	10	.80	Good
23	4	2	4	10	-.20	Not good
24	9	1	0	10	.80	Good
25	9	0	1	10	.80	Good
26	6	0	4	10	.20	Not good
27	9	0	1	10	.80	Good
28	9	1	0	10	.80	Good

The validation results using Lawshe's (1975) CVR index found that the socio-scientific issue attitude questionnaire instrument towards Chemistry learning consisted of 28 items, 17 were valid, and 11 were invalid. Seventeen good items consisted of 5 indicators: interest with symbol A consisting of 4 items, benefits with symbol B composed of 3 things, confidence with symbol C consisting of 3 items, liking with symbol D consisting of 3 items, and anxiety with symbol E consisting of 4 items. The 11 invalid items consisted of 3 indicators: culture, diversity, and religion. Invalid items are less relevant to the culture and condition of high school students in Indonesia. Valid items are then tested on 250 students throughout Indonesia who have used socio-scientific issue learning and tested by factor analysis using EFA and CFA.

Exploratory Factor Analysis (EFA)

EFA is a statistical method used to build structural models consisting of many variables. EFA is used when there is no preliminary information, or the hypothesis must be grouped into a variable whichever set of indicators has been made. Before proceeding to exploratory factor analysis, it is necessary to prove the adequacy of the sample first with the KMO and Bartlett's test. The sample is sufficient if the KMO Measure of Sampling Adequacy value is more than .50. Table 2 presents KMO and Bartlett's results.

Table 2. KMO and Bartlett's Test

KMO Measure of Sampling Adequacy		**.822**
Bartlett's Test of Sphericity	Approx. Chi-Square	1645.606
df		136
Sig.		.000

Table 2 shows that:

a. The KMO value is .822, more significant than .50, which indicates that the sample used is sufficient.

b. The Sig obtained is .000, indicating that the research variable can be predicted and analyzed further.

c. Bartlett's Test of Sphericity Approx. $\chi 2$ is obtained for 1645.606 at a significant .000, indicating a significant correlation between variables.

Table 2 proves that the trial sample of 250 respondents is sufficient for further analysis. Next, pay attention to the correlation matrix to see whether each item has a relationship. Table 3 shows the correlation matrix results.

Table 3. Correlation Matrix

	A1	**A2**	**A3**	**A4**	**B1**	**B2**	**B3**	**C1**	**C2**	**C3**	**D1**	**D2**	**D3**	**E1**	**E2**	**E3**	**E4**
A1	1.000	.516	.492	.564	.181	.203	.197	.206	.178	.270	.138	.186	.209	.260	.133	.134	.155
A2	.516	1.000	.578	.501	.232	.229	.199	.260	.171	.264	.158	.122	.123	.243	.119	.227	.229
A3	.492	.578	1.000	.499	.226	.190	.154	.211	.184	.305	.173	.146	.167	.177	.172	.211	.186
A4	.564	.501	.499	1.000	.315	.214	.243	.250	.209	.281	.219	.265	.228	.327	.233	.175	.232
B1	.181	.232	.226	.315	1.000	.533	.631	.186	.161	.127	.342	.325	.311	.227	.305	.212	.306
B2	.203	.229	.190	.214	.533	1.000	.593	.101	.102	.197	.213	.218	.245	.192	.231	.293	.264
B3	.197	.199	.154	.243	.631	.593	1.000	.140	.137	.133	.159	.216	.251	.249	.183	.241	.222
C1	.206	.260	.211	.250	.186	.101	.140	1.000	.517	.582	.129	.107	.107	.266	.271	.249	.175
C2	.178	.171	.184	.209	.161	.102	.137	.517	1.000	.516	.071	.044	.085	.243	.146	.195	.069
C3	.270	.264	.305	.281	.127	.197	.133	.582	.516	1.000	.118	.104	.156	.247	.188	.279	.201
D1	.138	.158	.173	.219	.342	.213	.159	.129	.071	.118	1.000	.581	.595	.177	.226	.109	.212
D2	.186	.122	.146	.265	.325	.218	.216	.107	.044	.104	.581	1.000	.614	.245	.241	.156	.274
D3	.209	.123	.167	.228	.311	.245	.251	.107	.085	.156	.595	.614	1.000	.224	.215	.203	.180
E1	.260	.243	.177	.327	.227	.192	.249	.266	.243	.247	.177	.245	.224	1.000	.532	.478	.594
E2	.133	.119	.172	.233	.305	.231	.183	.271	.146	.188	.226	.241	.215	.532	1.000	.492	.587
E3	.134	.227	.211	.175	.212	.293	.241	.249	.195	.279	.109	.156	.203	.478	.492	1.000	.585
E4	.155	.229	.186	.232	.306	.264	.222	.175	.069	.201	.212	.274	.180	.594	.587	.585	1.000

Table 3 shows that the correlation value is more significant than .05 and less than .90; this indicates that each item has a relationship, but the connection in each indicator still measures different things. Next is to analyze whether the resulting objects can be predicted or analyzed further by paying attention to the anti-image matrices produced. Santoso (2002) states that the following factor analysis requirement is that the Measures of Sampling Adequacy (MSA) value must be more than .50 in the Anti-image Correlation for each item with the item itself. Table 4 shows the results of the anti-image matrices analysis.

Table 4. Anti-image Matrices

	A1	A2	A3	A4	B1	B2	B3	C1	C2	C3	D1	D2	D3	E1	E2	E3	E4
A1	.853[a]	-.225	-.179	-.319	.080	-.056	-.040	.004	-.006	-.051	.067	-.025	-.092	-.090	.013	.073	.026
A2	-.225	.833[a]	-.362	-.168	-.020	-.066	.003	-.125	.033	.034	-.067	.053	.059	-.045	.152	-.073	-.078
A3	-.179	-.362	.844[a]	-.184	-.056	.017	.041	.065	-.015	-.128	-.033	.021	-.011	.100	-.067	-.070	.012
A4	-.319	-.168	-.184	.883[a]	-.120	.041	-.014	-.011	-.018	-.046	-.003	-.098	.016	-.124	-.051	.065	.023
B1	.080	-.020	-.056	-.120	.809[a]	-.209	-.455	-.070	-.091	.109	-.151	-.046	-.015	.103	-.127	.099	-.125
B2	-.056	-.066	.017	.041	-.209	.833[a]	-.375	.114	.035	-.144	-.041	-.004	-.007	.078	-.050	-.124	-.017
B3	-.040	.003	.041	-.014	-.455	-.375	.761[a]	-.027	-.006	.032	.124	-.005	-.078	-.134	.105	-.062	.051
C1	.004	-.125	.065	-.011	-.070	.114	-.027	.785[a]	-.277	-.407	-.038	-.023	.056	-.018	-.160	-.037	.068
C2	-.006	.033	-.015	-.018	-.091	.035	-.006	-.277	.792[a]	-.296	-.003	.036	.015	-.149	.024	-.064	.152
C3	-.051	.034	-.128	-.046	.109	-.144	.032	-.407	-.296	.791[a]	.006	.028	-.071	.016	.071	-.061	-.087
D1	.067	-.067	-.033	-.003	-.151	-.041	.124	-.038	-.003	.006	.801[a]	-.298	-.371	.021	-.048	.098	-.048
D2	-.025	.053	.021	-.098	-.046	-.004	-.005	-.023	.036	.028	-.298	.826[a]	-.383	-.028	.006	.055	-.124
D3	-.092	.059	-.011	.016	-.015	-.007	-.078	.056	.015	-.071	-.371	-.383	.788[a]	-.054	-.015	-.135	.132
E1	-.090	-.045	.100	-.124	.103	.078	-.134	-.018	-.149	.016	.021	-.028	-.054	.853[a]	-.234	-.104	-.340
E2	.013	.152	-.067	-.051	-.127	-.050	.105	-.160	.024	.071	-.048	.006	-.015	-.234	.851[a]	-.178	-.273
E3	.073	-.073	-.070	.065	.099	-.124	-.062	-.037	-.064	-.061	.098	.055	-.135	-.104	-.178	.848[a]	-.345
E4	.026	-.078	.012	.023	-.125	-.017	.051	.068	.152	-.087	-.048	-.124	.132	-.340	-.273	-.345	.802[a]

[a] Measures of Sampling Adequacy (MSA)

Table 4 shows that the MSA values are more significant than .50 and less than 1.0, which indicates that the existing indicators have errors by other items meaning that each indicator can be predicted and analyzed further. Furthermore, the values of communalities indicate whether the variable under study can explain the factor and is feasible for further analysis. Table 5 shows the value of communalities.

Table 5. Communalities

	Initial	Extraction
A1	1.000	.651
A2	1.000	.670
A3	1.000	.642
A4	1.000	.633
B1	1.000	.714
B2	1.000	.697
B3	1.000	.783
C1	1.000	.705
C2	1.000	.690
C3	1.000	.695
D1	1.000	.725
D2	1.000	.733
D3	1.000	.727
E1	1.000	.642
E2	1.000	.656
E3	1.000	.626
E4	1.000	.762

Communalities function to ensure the data does not deviate in factor analysis. Table 5 shows that the communalities value is in the range of .626 to .783, which indicates that all items are eligible for research and can be continued at the next stage. It shows that the 17 things developed in this study can explain the factors and further analysis. To determine how many factors can be used as a reference in creating the socio-scientific issue attitude instrument in this study, one can use eigenvalues in the screen plot of Figure 1.

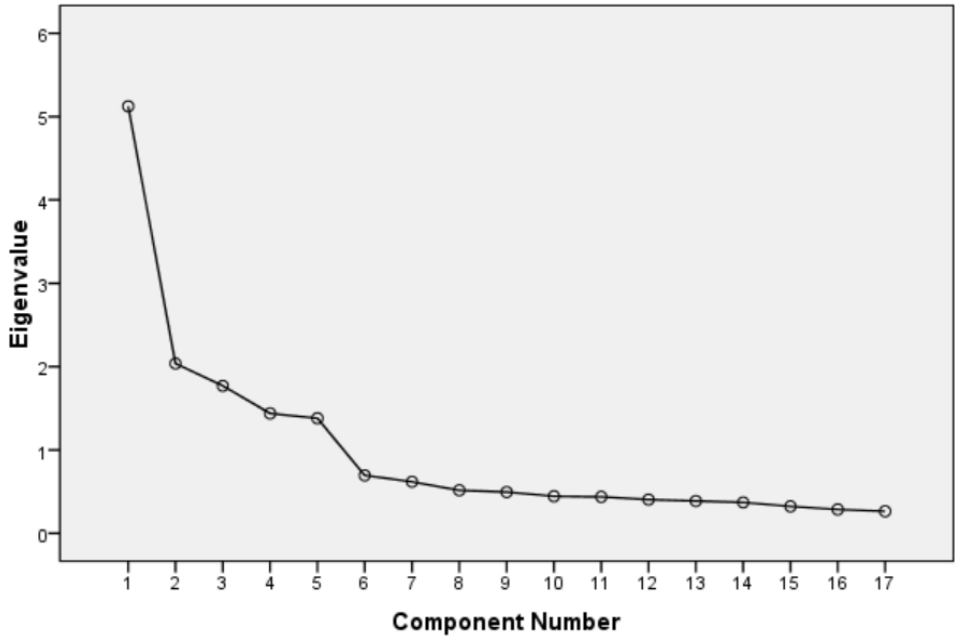

Figure 1. Scree Plot Results

Figure 1 shows five factors with eigenvalues greater than 1 and 12 with eigenvalues less than 1, which indicates that five elements became a reference in this study's development of the socio-scientific issue attitude instrument. The five factors in this instrument are not directly based on the previously created factors but on the rotated component matrix to ensure which items are included in elements 1 to factor 5. Table 6 shows the types of characteristics and things included in these factors.

Table 6. Rotated Component Matrix

	Component				
	1	2	3	4	5
A1	0.059	0.787	0.102	0.076	0.106
A2	0.122	0.792	0.002	0.125	0.111
A3	0.092	0.78	0.066	0.071	0.127
A4	0.149	0.737	0.179	0.135	0.133
B1	0.158	0.141	0.264	0.771	0.076
B2	0.159	0.13	0.093	0.802	0.048
B3	0.116	0.107	0.079	0.865	0.069
C1	0.176	0.137	0.06	0.041	0.807
C2	0.056	0.082	0.008	0.083	0.82
C3	0.144	0.224	0.056	0.053	0.786
D1	0.083	0.095	0.833	0.107	0.053
D2	0.163	0.104	0.826	0.119	-0.001
D3	0.103	0.097	0.824	0.156	0.067
E1	0.749	0.188	0.122	0.067	0.162
E2	0.778	0.042	0.163	0.104	0.11
E3	0.75	0.087	0.006	0.165	0.17
E4	0.846	0.12	0.115	0.136	-0.009

Table 6 shows a loading factor of more than .50, and no overlapping factors exist. This result forms the names of the factors:

1. Factor 1 is anxiety (E); the items included in this factor are E1, E2, E3, and E4.
2. Factor 2 is interest (A); the items included in this factor are A1, A2, A3, and A4.
3. Factor 3 is favorite (D); the items included in this factor are D1, D2, and D3.
4. Factor 4 is a benefit (B); the items included in this factor are B1, B2, and B3.
5. Factor 5 is self-confidence (C); the items included in this factor are C1, C2, and C3.

Table 7. Exploratory Factor Analysis Results

	Socio-Scientific Issue Items	Loading Factor
Factor 1: Anxiety		
14	I feel unable to answer a friend's question during a discussion.	.749
15	I do not understand the problems discussed in class.	.778
16	My friends laugh at me if I cannot answer during the discussion.	.750
17	I am afraid of the low chemistry score.	.846
Factor 2: Interest		
1	I feel alienated from studying chemistry.	.787
2	I love hearing other people's opinions.	.792
3	I'm happy to hear the teacher's explanation.	.780
4	The social issues discussed are fascinating.	.737
Factor 3: Favorite		
11	Discussing with friends is the most fun thing.	.833
12	Finding out about new things in chemistry is very interesting.	.826
13	I hesitate to express my opinion about chemistry.	.824
Factor 4: Benefit		
5	Chemistry is close to everyday life.	.771
6	The problem discussed is something we often encounter	.802
7	Discussion trains my mind to speak in public.	.865
Factor 5: Self-confidence		
8	Chemistry material is easier to understand	.807
9	The discussion material made me read many of learning resources.	.820
10	A collective discussion made me more interested in chemistry.	.786

The five factors with 17 items produced correspond to the socio-scientific issue in chemistry and cultural learning in Indonesia. Then the coefficient of reliability is determined. Table 8 presents the results of the reliability analysis.

Table 8. Student Character Instrument Reliability

Factor	Number of Items	Cronbach's Alpha
Anxiety (E)	4	.826
Interest (A)	4	.815
Favorite (D)	3	.815
Benefit (B)	3	.809
Self-confidence (C)	3	.778
Total	17	.853

These results found that the instrument for assessing students' attitudes towards SSI in chemistry learning had a high level of consistency and was feasible to use later because it had an absolute coefficient of .778 to .826 with a total reliability coefficient of .853. Because the results are feasible and reliable, the factor analysis can be continued in the confirmatory factor analysis to strengthen the factor analysis.

Confirmatory Factor Analysis (*CFA*)

CFA is used to test whether the indicators that have been grouped based on their latent variables (constructs) are consistent in this construct. 250 respondents in the CFA analysis is the same as the number of respondents used in the EFA analysis.

In the output t-value (Figure 2), if it has a value between -1.92 and 1.92, it must be removed from the model. Whereas in Standard Solution (Figure 3), if an item has a loading factor of more than .60, then the thing is called fit.

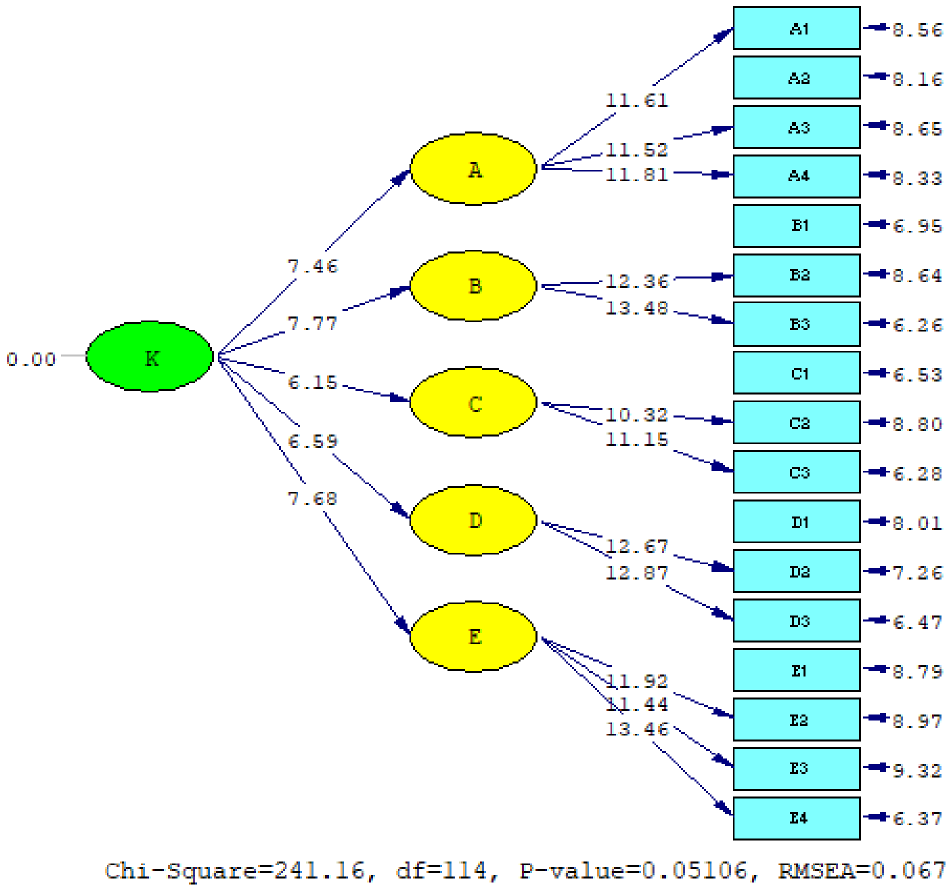

Figure 2. t Values of the Student Attitude Assessment Instrument

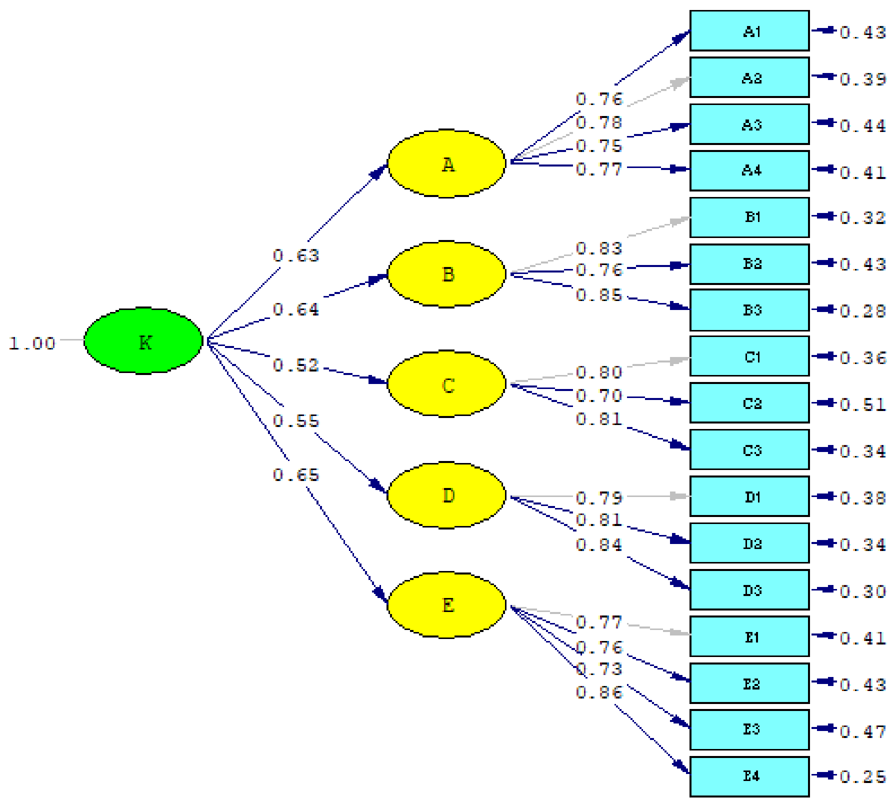

Figure 3. Standard Solution for Assessment of Student Attitudes

Figure 2 shows that there is no value between -1.92 to 1.92, so no items are removed from the model. Meanwhile, in Figure 3, all things have a loading factor of more than .60, so the instrument is called fit. The most significant part of the CFA analysis is the feasibility analysis of the tool. Much information can be used to determine if the device is fitted. This study uses several references: it is fit if the p-value is more than α and the RMSEA is close to 0 (Retnawati, 2017). Another reference states that a model is fit if the χ2 value is less than two df (Arbuckle, 1997), p-values are more significant than .05 (Ferdinand, 2002; Pedhazur, 1997), the root mean square error of approximation (RMSEA) is less than or equal to 0.08 (Ferdinand, 2002; Sarwono, 2010) and goodness of fit index (GFI) is greater than or equal to or close to .90 (Ferdinand, 2002; Pedhazur, 1997) or closer to one (Sarwono, 2010). Based on the analysis results using CFA and the references used, the results are presented in Table 9.

Table 9. Instrument Feasibility Analysis

Category Name	Index name	Admission Category	Analysis Results	Information
Absolute fit	Chi-Square	P-value > .05	.051	Fit
	RMSEA	RMSEA < .08	.067	Fit
	GFI	GFI > .90	.91	Fit
Incremental fit	AGFI	AGFI > .90	.86	Not fit
	CFI	CFI > .90	.96	Fit
	IFI	IFI > .90	.96	Fit
	NFI	NFI > .90	.93	Fit
Parsimonious fit	Chisq/df	Chi-Suare/ df < 3.0	2,12	Fit

Table 9 shows seven fit conditions from 8 acceptance categories, which concludes that the instrument construct is proven valid (construct validity is met) so that the construct of the instrument for assessing attitudes towards socio-scientific issues in chemistry learning consists of five factors: the anxiety factor (E), with the items formed on this factor, are E1, E2, E3, and E4, the element of interest (A), with items what is included in this factor are A1, A2, A3, and A4, the favorite aspect (D), with the things formed on this factor are D1, D2, and D3, the benefit factor (B), with the items included on this factor is B1, B2, and B3 as well as the confidence factor (C), with items formed on this factor are C1, C2, and C3 valid and reliable.

Discussion

Socio-scientific issues provide contextual dimensions of learning experiences that can change the nature of these experiences and the meaning and significance of learning (Sadler, 2009). Previous research has discussed socio-scientific issues in science learning (Lee & Grace, 2012; Sadler, 2004; Sadler et al., 2004, 2007; Topcu, 2010; Zeidler et al., 2005; Zeidler & Keefer, 2003). This study focuses on student attitudes in learning socio-scientific issues, especially in learning chemistry. The facts show that students' attitudes are essential in predicting final achievement in general chemistry (Xu & Lewis, 2011).

The validation results using CVR found five valid factors: anxiety, interest, liking, benefit, and self-confidence. Students' anxiety has a role in determining their attitude towards learning socio-scientific issues in chemistry learning. Anxiety factors affect class preparation, affecting classroom learning (Peltier et al., 2021). The second factor is interest. Students' interest in learning socio-scientific issues and chemistry is essential to survive in education. Interest is a unique motivational characteristic (Schiefele, 1991) and determines choosing and persisting (Hidi, 1990). The third factor is liking. Students who like learning about socio-scientific issues will pay more attention and be diligent in finding new information. People interested in something provide more optimal performance, excellent concentration, and perseverance (McIntyre et al., 2021). The fourth factor is benefits. Knowing the benefits of learning about socio-scientific issues in chemistry will solve every chemistry-related problem. The fifth factor is self-confidence, which helps students learn socio-scientific issues to understand chemistry better. Students with high self-confidence increase in learning outcomes tests (Hong et al., 2017).

Previous research on the socio-scientific issue attitude instrument has been carried out by Topcu (2010) by obtaining three factors: interest and usefulness of socio-scientific issues, liking of socio-scientific issues, and anxiety towards socio-scientific issues. The previous research is similar to the three factors obtained in this research. This research differs in using five elements: interest, benefit, liking, anxiety, and self-confidence. Previous research combined the importance and usefulness of socio-scientific problems into one factor, while this research separated the interest and use of the socio-scientific problems into interest and benefit factors. In addition, this research differs on self-confidence, which is essential because it can lead to positive perceptions (Hanton et al., 2004). The five single elements were obtained to make the validity received more transparent.

The results of the EFA analysis show that the 250 research samples are sufficient because KMO > .50 (Yong & Pearce, 2013), so the research can be analyzed further. The results of the CFA further show that each item on each factor provides a significant model fit. All aspects are fit and fulfilled, meaning that the model is suitable, for example, in the first and second factors. The first factor, anxiety, has four valid and reliable items: fear of answering friends' questions, not understanding the problem being discussed, being laughed at, and being afraid of low chemistry scores. Akbas and Kan (2007) state that chemistry lessons' anxiety is a significant predictor. The second factor is interest in having four items: feeling unfamiliar with chemistry, happy with the teacher's opinion, happy with other people's opinions, and interested in the social problems discussed. According to Akram et al. (2017), the professional scope and role of the teacher can reduce student interest. The two examples of these factors illustrate that the model used is appropriate.

Conclusion

The results showed that the attitude assessment instrument on the socio-scientific issue in chemistry learning was declared valid and reliable because it met all the criteria for content and constructed validity in the form of EFA and CFA. This study's findings increase knowledge and information about socio-scientific issues in learning. Chemistry teachers or other researchers can use this instrument to determine student attitudes towards socio-scientific issue learning that has been carried out, both on anxiety factors, interests, preferences, benefits, and students' self-confidence in learning chemistry using socio-scientific issue learning.

Recommendations

Based on the study findings, further researchers can combine the aspects of the socio-scientific issue of this research with the cognitive aspects of the socio-scientific case. Combining attitudinal and mental elements in learning socio-scientific issues can obtain maximum results. The results of the socio-scientific issue attitude research in this study can be used at the end of chemistry learning that applies socio-scientific problem learning to identify student attitudes so that it can be input for chemistry teachers to improve chemistry learning.

Limitations

This research has obtained a valid and reliable attitude assessment instrument towards socio-scientific issues in chemistry learning, but this research has limitations from the scope of the research place. The study was only conducted in senior high schools in Indonesia. This research needs to be done in collaboration with other countries to obtain more data from high school and junior high students.

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Appendix

Socio-Scientific Issue Items	**Answer**				
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I feel alienated from studying chemistry.					
I love hearing other people's opinions.					
I'm happy to hear the teacher's explanation.					
The social issues discussed are fascinating.					
Chemistry is close to everyday life.					
The problem discussed is something we often encounter.					
Discussion trains my mind to speak in public.					
Chemistry material is easier to understand.					
The discussion material made me read many learning resources.					
A collective discussion made me more interested in chemistry.					
Discussing with friends is the most fun thing.					
Finding out about new things in chemistry is very interesting.					
I hesitate to express my opinion about chemistry.					
I feel unable to answer a friend's question during a discussion.					
I do not understand the problems discussed in class.					
My friends laugh at me if I cannot answer during the discussion.					
I am afraid of the low chemistry score.					