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Development of Critical and Creative Thinking Skills Instruments Based on Environmental Socio-Scientific Issues

Yatin Mulyono
Universitas Sebelas Maret, Indonesia, *mulyono.yatin@iain-palangkaraya.ac.id*

Suranto
Universitas Sebelas Maret, Indonesia, *suranto57@staff.uns.ac.id*

Sri Yamtinah
Universitas Sebelas Maret, Indonesia, *jengtina@staff.uns.ac.id*

Sarwanto
Universitas Sebelas Maret, Indonesia, *sarwanto_fkip@staff.uns.ac.id*

This study aims to produce an instrument model for critical and creative thinking skills based on environmental socio-scientific issues and test the validity and reliability. First, field studies and needs analysis use a design and development approach. Namely: (1) problems, (2) goal setting, (3) model design and development, (4) model testing, (5) evaluation of the test results model, and (6) application model. Then, the planning and development stages are carried out using a literature study to obtain a formulation of indicators which are then developed into a grid and a prototype instrument. The trial sample describes 277 science teacher candidates from 3 universities in Indonesia. Proof of content validity using the Aiken formula by seven experts and getting a score of 0.84 in the excellent category. The measurement model reliability assessment includes Composite Reliability with a value of 0.89 in the reliable category. Confirmatory factor analysis shows that the instrument model is fit or the stated model is by the data obtained in the field and can be used in a wide range of measurements.

Keywords: critical thinking, creative thinking, environmental socio-scientific issue, instrument model, thinking skills

INTRODUCTION

Critical and creative thinking skills are fundamental in science learning in the 21st century. The demands for 21st-century skills known as 4Cs include critical thinking, communication, collaboration, and creativity (Almerich et al., 2020; Astuti et al., 2019; Kembara et al., 2019; Khoiri et al., 2021; Ku & Au, 2021). These skills include accessing, analyzing, and synthesizing information that can be learned, practiced, and mastered (Fong et al., 2017; Kembara et al., 2019). False and misleading information

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abounds in the post-truth age (Ku & Au, 2021). The flow of information is increasing, so students need to have the ability to choose good and relevant sources of information in this digital literacy era. Students must be able to find quality sources and evaluate them in terms of objectivity, reliability, and timeliness (Hand et al., 2018; Wechsler et al., 2018). One of the students' capitals in making decisions is their ability to distinguish truth from lies, fact from opinion or fiction from non-fiction from the information received (Dwyer & Walsh, 2020; Wardani et al., 2017). One of the 4Cs equally important in 21st-century skills is creative thinking skills in creating innovations (Gu et al., 2019). Students can generate, develop, and implement their ideas creatively so that, through these skills, students can survive and cannot be replaced by machines/robots in their professional field (Ritter & Mostert, 2017).

Higher-order thinking skills (HOTs) are essential for students because they can help students solve problems in learning (Abdullah et al., 2015; Almerich et al., 2020; Tan & Halili, 2015). Therefore, HOTs are one of the main focuses of 21st-century learning (Hassan et al., 2018; Sukla & Dungsungneon, 2016). The implementation of HOTs-based learning facilitates students to think critically, logically, and systematically according to the characteristics of subjects and learning materials and has high-level thinking skills.

21st-century learning needs to place HOTs as an essential student need, and learning needs to be designed to improve HOTs. According to Anderson & Krathwohl (2001), HOTs encourage logical reasoning when considering answers or recognizing and pursuing scientific studies of facts. They also assist students in remembering, understanding, and applying what they have learned. However, when people engage in learning and thinking, they may encounter issues, doubts, questions, or unanticipated issues and situations. (Makmuri et al., 2021). Students who demonstrate HOTs include critical thinking and creative thinking competencies.

The creativity of students needs to be nurtured, developed and improved. Creative thinking has long been seen as an essential basis for pupils (Gu et al., 2019; Gube & Lajoie, 2020; Ritter & Mostert, 2017; Srikongchan et al., 2021). People that think about science must be able to think creatively (Komaria & Wicaksono, 2019). The more creativity will grow if students have high motivation, curiosity, and imagination, the more creative results will be. Through creativity, students can be creative according to their abilities and talents. As a result, students can solve problems and improve the quality of their future lives. Creativity is increasingly important to be taught to prepare graduates' competencies to think creatively in the work environment, personal life and society. However, more is needed to know about how to teach creativity. Research by Deta et al. (2013) stated that learning methods, creativity, and science process skills affect cognitive and affective learning achievement.

Meanwhile, the results of research by Hamid (2017) & Ulger (2018) show that students' critical and creative thinking styles are related to their cognitive abilities. Therefore, learning needs to be oriented towards HOTs, which include aspects of critical and creative thinking (Mahanal, 2019; Sajidan & Afandi, 2017; Zohar & Alboher Agmon, 2018). The teacher's perception of applying critical thinking skills has two main aspects:

the difficulty aspect and the teacher's activeness in using students' critical thinking skills (Ridwan et al., 2022). The research results of Qiang et al. (2020) stated that structural equation modelling has shown that students' critical thinking dispositions are positively related to scientific creativity. Less sampling hurts metacognitive sentiments, which negatively impacts creative self-efficacy, according to Puente-Diaz & Cavazos-Arroyo (2020) research. The capacity for creativity and the enjoyment of the activity are thus indirectly influenced by metacognitive sentiments via creative self-efficacy. The integration of learning based on the environmental socio-scientific issue (ESSI) is a study of contemporary controversial issues about the environment. That involves students in dialogue, discussion or debate of moral reasoning or evaluating ethical issues in the decision-making process regarding possible solutions to environmental problems. Through this approach, students are stimulated to grow their critical and creative thinking in a multi-disciplinary and integrative manner about scientific problem solving and moral values. One benefit of ESSI integration is that it forces students to develop various critical thinking abilities and dispositions via discussion and debate on contentious social subjects. Additionally, analytical, inference, explanation, assessment, interpretation, and self-regulation depend on creative thinking abilities (Salleh et al., 2012; Wale & Bishaw, 2020). Thus, including ESSI components can aid in producing truth-seeking pupils who are receptive, analytical, methodical, innovative, and growingly self-assured in their thinking.

The curriculum of the Education Personnel Education Institution is structured so that its graduates have the competence to develop the potential of students as the national education goal. That is characterized by the development of attitudes, knowledge, and skills integrated by the proficiency of graduates at each level of education based on the new curriculum and contemporary demands. That refers to The Indonesian National Qualifications Framework and the future to ensure the quality of prospective professional educators (Rustad et al., 2013). The Indonesian National Qualifications Framework level 6-based curriculum emphasizes critical and creative thinking skills possessed by students because apart from being able to support cognitive abilities, they are also needed in solving problems in students' lives (Amaliah et al., 2020; Budi & Ghofar, 2017). That is supported by the achievement of learning outcomes (LO) of science learning in the higher education curriculum. That refers to KKNI level 6, which includes students being able to think logically, critically, systematically, and innovatively in developing or implementing science and technology that pays attention to and applies values in humanities.

The curriculum document in the Mathematics and Natural Sciences Education Department places critical and creative thinking skills competence as one of the main achievements. However, it still needs a valid and reliable instrument model for measuring students' critical and creative thinking skills. So the assessment instrument needs to be integrated with a supportive approach to measuring critical and creative thinking skills more effectively. This study aims to develop an instrument of critical and creative thinking skills that are valid and able to measure variables both in content and construction. The development of critical and creative thinking skills instruments becomes essential as an evaluation tool and measures the curriculum achievements of prospective science teacher students.

Previous research on developing critical and creative thinking instruments, among others, by Kriswantoro et al. (2021) developed an integrated critical thinking assessment model with chemical science process skills for senior high school students. Furthermore, Sari et al. (2018) developed learning instruments using creative problem-solving models to improve students' creative thinking skills in mathematics. Then Amrina et al. (2018) developed an instrument to measure logic, critical, and creative thinking competencies. The results of this study develop a new instrument model to measure critical and creative thinking skills based on environmental socio-scientific issues. The formulation of indicators in this instrument refers to the formulation by experts and is synthesized to suit the characteristics of learning based on environmental socio-scientific issues. So the results of this study provide a new reference related to learning instruments.

METHOD

This study uses a Design and Development (D&D) approach, namely: (1) problem, (2) goal setting, (3) model design and development, (4) model testing, and (5) model evaluation results. Testing, and (6) application models. This approach systematically studies the design, development, and evaluation processes to build an empirical foundation for creating new instructional products, tools, and models. The product produced in this study is an instrument model of critical and creative thinking skills based on the environmental socio-scientific issue. Field studies and needs analysis carry out problem analysis. The result of this study is goal setting, namely the development of critical and creative thinking instruments based on environmental socio-scientific issues. The planning and development stages refer to the theory of definitions and indicators of critical and creative thinking skills and the integration of environmental socio-scientific issues to obtain a synthesis of indicators. The instrument grid was then developed based on the indicator formulation. The prototype instrument was developed based on the grid. Finally, test the instrument's validity using content validity with the Aiken formula from 7 expert validators.

$$V = \frac{\Sigma s}{[n(c-1)]} \qquad (1)$$

Information:
s = r – lo
lo = the lowest number of validity assessment
c = the highest validity score
r = the score given by the assessor

Construct validity test with Confirmatory Factor Analysis (CFA) using Linear Structural Model (Lisrel). The sample used is student science teacher candidates from 3 universities in Indonesia, totalling 277 people. Data collection techniques through tests. It is used to assess whether the theoretical construct has been satisfied if the construct has not been met and the degree to which the empirical evidence in the field supports the theoretical construct that has been defined. The suitability of the instrument with field data is known by using the criteria if the value: p, value = 0.05, then interprets the acquisition of the value of goodness of fit indices (GFI) 0.09, then the value of adjusted goodness of fit index (AGFI) < 2.00 and the value of the root mean square error of approximation (RMSEA) 0.08. The measurement model reliability assessment includes Composite Reliability (CR) and Average Variance Extracted (AVE). CR and AVE are found by equations (2) and (3).

$$AVE = \frac{\Sigma LF^2}{\Sigma LF^2 + \Sigma(1 - LF^2)} \quad (2)$$

$$CR = \frac{(\Sigma LF)^2}{[(\Sigma LF)^2 + \Sigma(1 - LF^2)]} \quad (3)$$

Information:
LF = loading factor

FINDINGS

Planning Stage

A model or prototype is designed and developed at this stage. A literature review and findings synthesis are completed to support the development model. The prototype 1 model's essential design phase is complete, and model testing is still ongoing. The literature review in this stage looks at evaluation techniques as the foundation for creating an early design model or prototype, as well as the ideas of critical and creative thinking as higher order thinking (HOTS). In order to get research insights into the theories, processes, steps, and methodologies employed in development research, the notion of critical and creative thinking was also evaluated. Through this activity, it is hoped that prospective science teacher students can obtain an empirical study on applying critical and creative thinking assessment skills to environmental issues. A review of relevant research results shows that critical and creative thinking assessments strongly support university science learning. Therefore, it is possible to ascertain these pupils' talents using the model for assessing critical and creative thinking.

The challenges and needs were then examined using the findings from the literature review and the first activities. The investigation of the issue reveals that the previously created test instrument does not currently assess critical and creative thinking abilities. The previously created critical and creative thinking test instrument still needs a more advanced evaluation approach. The previously developed evaluation methods have yet to be able to quantify and enhance critical and creative thinking abilities.

A problem analysis was done to find research models that could enhance students' critical and creative thinking abilities when learning about environmental challenges. This study's needs analysis revealed that (1) it is essential to create an instrument model that can test critical and creative thinking abilities, and (2) the assessment model created can identify the learning deficits of aspiring science teacher students.

Development Stage

The results of this development are in the form of a test instrument product to measure critical and creative thinking skills on environmental issues for prospective science teacher students. In the early stages of development is to develop a prototype and validated it. This activity aims to produce products in the form of instruments that can be applied correctly and effectively. The assessment tools, directions, and instructions for interpreting the assessment findings make up the prototype. Design activities, such as planning objectives, tools, and implementation guidelines, are used to carry out prototype planning. Experts in the fields of environmental science and the evaluation of environmental education then assessed the assessment prototype's initial design.

Instruments of critical and creative thinking skills are formulated based on the synthesis of definitions and indicators from experts. The synthesis of critical thinking indicators by researchers based on the formulations of experts was carried out because they adjusted to the syntax of the model and the material for environmental problems, as presented in Table 1.

Table 1
Synthesis of critical thinking skills indicators

Ennis (1993)	Scriven & Paul (2007)	Fisher (2007)	Johnson (2011)	Synthesis Result
Formulate the main points of the problem	Conceptualize	Identify the problem	Solve the problem	Formulate the problem
Reveal the facts	Apply	Gather relevant information	Make decisions	Evaluating arguments
Choose logical arguments	Analyze	Develop several alternative solutions to problems	Persuade	Considering the credibility of the data
Detect bias with different points of view	Synthesize	Making a conclusion	Analyzing assumptions	Making a conclusion
Draw conclusions	Evaluate	Expressing opinion	Doing scientific research	Able to make the right decisions in solving problems
	Faith and action	Evaluating arguments		

The operational definition of each critical thinking skill indicator based on the synthesis results and indicators is presented in Table 2.

Table 2
Operational definitions of critical thinking skills indicators

Indicator	Operational definition	Technical
Formulate the problem	The ability to take inventory or problem recognition by questioning a variable or the relationship between one or more variables in a phenomenon	Given a narrative about environmental problems and their impact on society, students can formulate problems based on the narrative.
Evaluating arguments	Ability to analyze/evaluate data, opinions, justifications, support, and refutation of problems	Given a narrative about the environmental socio-scientific issue (ESSI), students can provide responses (support/deny) to the claims.
Considering the credibility of the data	Ability to consider whether data can be trusted or not	Given a narrative about ESSI, students can accept or reject it based on facts and data as well as students' perspectives.
Making a conclusion	The ability to make deductions and consider the results of deductions or make inductions and consider the results of inductions	Given a narrative about ESSI, students can respond and give reasons for the conclusions in the narrative.
Able to make the right decisions in solving problems	Ability to find alternative actions based on data, analyse and choose the best alternative actions to solve a problem	Students can formulate alternative actions to overcome these problems by giving a narrative about ESSI.

The synthesis of creative thinking indicators by researchers based on the formulations of experts was carried out because they adjusted to the syntax of the model and the material for environmental problems, as presented in Table 3.

Table 3
Indicators of creative thinking

Guilford (1956)	Torrance et al., (1990)	Williams (1993)	Kaufman et al., (2008)	synthesis result
problem sensitivity				problem sensitivity
Fluency	Fluency	Fluency	fluency	Fluency
Flexibility	Flexibility	flexibility	Flexibility	Flexibility
Originality	originality	originality	Originality	Originality
Elaboration	elaboration	elaboration	Elaboration	elaboration

The operational definitions of each dimension and indicators of creative thinking skills are presented in Table 4.

Table 4
Operational definitions of each indicator of creative thinking skills

Indicator	Operational definition	Technical
problem sensitivity	Ability to recognize and understand and respond to problems or situations encountered	Given a narrative about industrial activities, students can explain the good and bad impacts that may be caused on the environment and society.
Fluency	Ability to think efficiently, understand information and generate lots of ideas.	Given information about environmental problems, students can develop relevant ideas/solutions.
Flexibility	The ability to understand a phenomenon from multiple perspectives / multiple points of view	Given a narration about the phenomenon of science and technology progress, students can give their responses from multiple perspectives.
Originality	Ability to come up with unique ideas, different from existing ones	Given a narrative of the phenomenon of environmental problems, students can express their ideas that are different from others.
elaboration	Ability to enrich and develop an idea or product; adding or detailing in detail an object, idea, or situation so that it becomes more attractive than before	Given a narration about an example of solving environmental problems, students can refine the idea by adding or detailing it in more detail.

The prototype instrument was developed based on the indicator formulation. The results of the instrument validity test use content validity with the Aiken formula of 7 validators. Several recommendations and inputs about the design of the prototype assessment model were received based on the research of experts and were categorized as follows: In order to have an advantage, features must be plainly and evaluated. The instrument must also represent the principles of assessment. Finally, assessment guidelines must be produced in a practical, thorough, and transparent way. The assessment model prototype was fixed and improved and then evaluated by professionals to create a workable and appropriate model for usage. The Aiken reference value is 0.80 based on the Aiken table for statements evaluated by seven experts, with the criteria for the score range utilized from 1 to 5 and a significance of 0.05. The results of the expert assessment showed that all items met the minimum score, and an average score of 0.84 was obtained. Therefore, the calculation results can be concluded that the content of this instrument is declared valid.

Product Trial Results

Product trials were conducted to measure the validity and reliability of the product. The results of the construct validity test using Confirmatory Factor Analysis (CFA) using the Linear Structural Model (Lisrel) are presented in Figure 1.

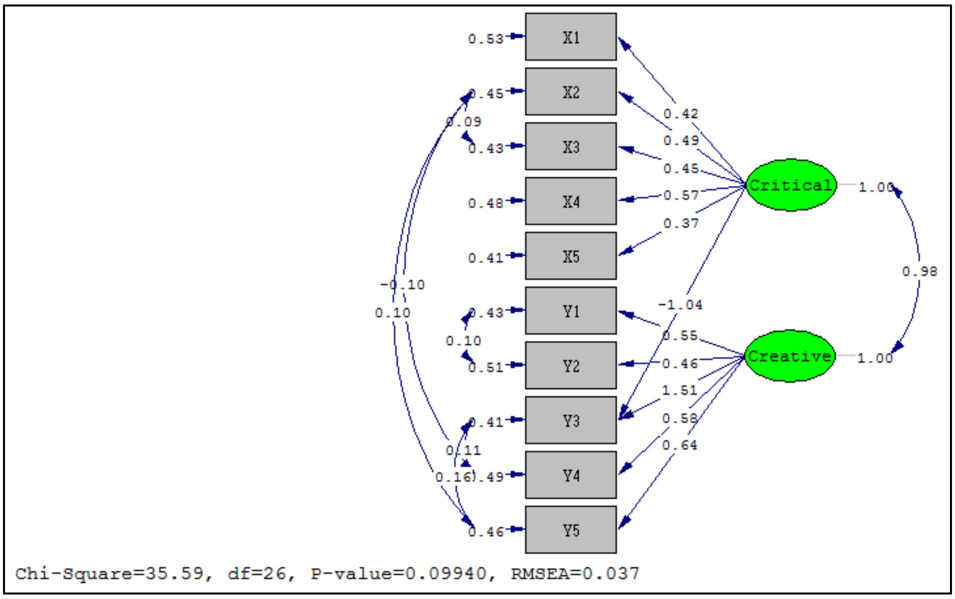

Figure 1
Output diagram of estimate

Figure 1 shows the model fit. The interpretation of the analysis results in detail is presented in Table 5.

Table 5
Model fit test result

Indicator	Score Benchmark	Score Acquisition	Model Fit
Chi-Square/df	≤ 2.00	1.37	Good
Probability (p-value)	≥ 0.08	0.099	Good
Root Mean Square Error of Approximation (RMSEA)	≤ 0.08	0.037	Good
Goodness of Fit Index (GFI)	≥ 0.90	0.97	Good
Comparative Fit Index (CFI)	≥ 0.90	0.99	Good
Relative Fit Index (RFI)	≥ 0.90	0.96	Good
Incremental Fit Index (IFI)	≥ 0.90	0.99	Good
Adjusted Goodness of Fit Index (AGFI)	≥ 0.90	0.95	Good
Parsimony Goodness of Fit Index (PGFI)	≥ 0.05	0.46	Good

According to the perspective of Jöreskog & Sörbom (1989), a model is considered to fulfill the criteria of a suitable model if it meets at least three model fit indices. Empirical evidence from the area supports the theoretical constructs that have been created: the Chi-Square (2), RMSEA, P-Value, and GFI fit model indices. In general, the values acquired are within the necessary intervals. Therefore it may be claimed that the model created is appropriate since the Goodness of Fit standards have been satisfied. The instrument build, in particular, is effective and suitable for varied measurements.

The output t-values, shown in Figure 2, can be used to determine the significance of the relationship between variables.

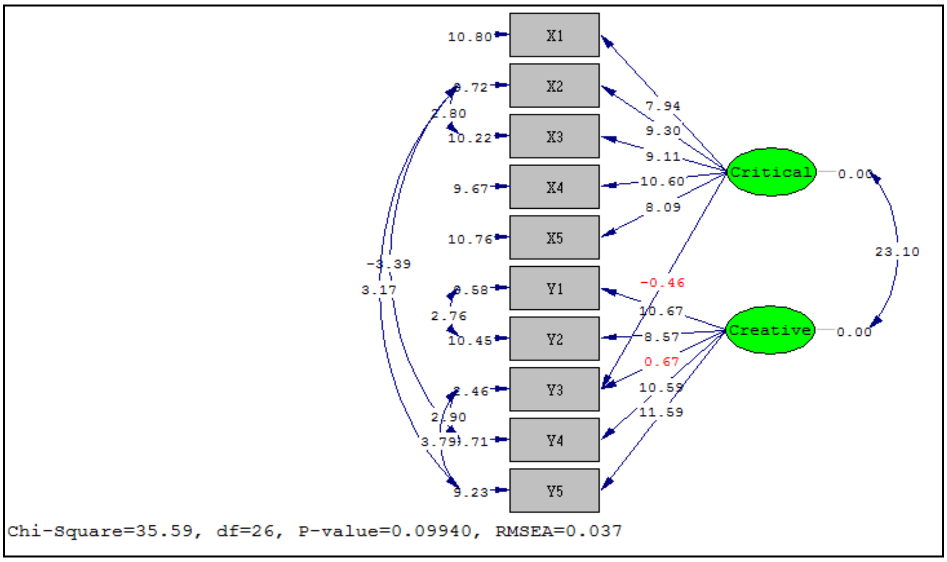

Figure 2
Output -values

The t-statistical test is then used to determine the significance of the parameters after obtaining a satisfactory model. When the t-values are red, the significance of the meaning is not relevant, but when they are black, it is. For example, figure 2 demonstrates that the Critical indicator for the Y3 item and Creative for the same item, Y3, are still two negligible connection items. Comparing the t value with the crucial t value allows for path testing. For example, at alpha 0.05 (significance level 5%), the crucial t value is 1.97. The analysis's findings reveal a t-value of more than 1.97. The loading of the critical and creative indicators' effect factors on each item is then examined as part of an analysis. The results of the analysis using LISREL are displayed in Figure 3.

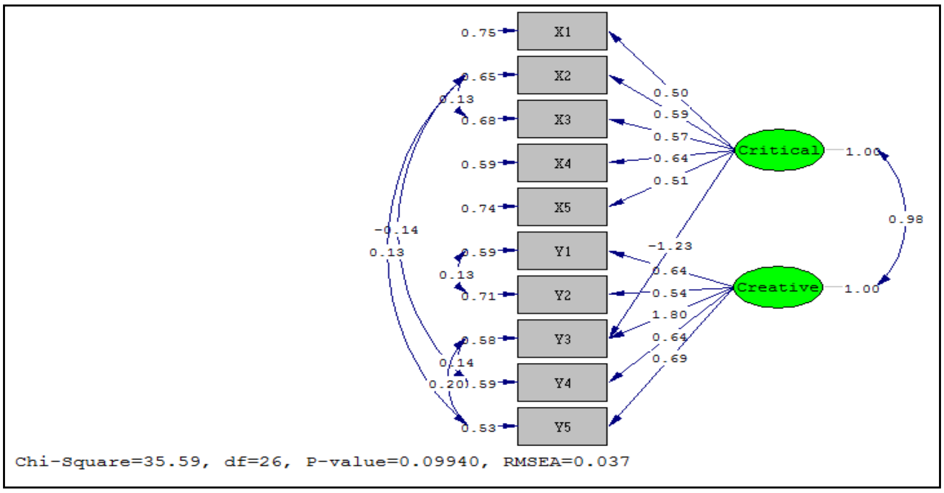

Figure 3
Output path diagram of standardized solution analysis results

Once it is established that the model fits, an analysis is conducted to see whether the construct is valid. The expected loading factor (LF) value for each indicator or dimension was considered while performing the construct validity test. The standard loading factor set so that the item is valid is at least 0.5 (Retnawati, 2016). The analysis results show that the standard loading factor value meets the valid criteria. The two developed indicators may therefore be used to describe the model. Because the total Average Variance (AVE) was higher than the 0.5 minimum requirement, the convergent validity test findings in this study were fulfilled. In addition, all fit test/goodness of fit model requirements are satisfied, and construct validity is also met (Table 5). Therefore, any object is appropriate for measuring indicators.

The next step is to do a reliability test. That is done to gauge how well the measurement model captures the targeted latent component. Table 6 evaluates the measurement model's reliability, including Composite Reliability (CR) and Average Variance Extracted (AVE).

Table 6
Reliability analysis results

	Score	Information
∑LF	7.12	
(∑LF)2	50.69	
∑LF2	6.42	
∑(1-LF2)	6.41	
CR	0.89	Reliable
AVE	0.5	Reliable

Table 6 shows the results of the reliability test value of CR 0.89 so that it is declared reliable, as well as the results of AVE 0.5 so that it meets the reliable criteria. The root means standardized loading factor is divided by the number of indicators to determine the AVE. AVE can demonstrate the latent variable's capacity to represent the initial data results accurately. The capacity to explain the value of the indicator measuring the hidden variable is higher than the AVE value. The AVE cut-off value is often 0.50, whereas the minimum AVE value is 0.50. Therefore, the indicator of the variable is said to be reliable if the value of AVE is 0.5 and CR 0.7 (Sürücü & Maslakci, 2020). The analysis's findings demonstrate that convergence validity is vital, implying a 50% chance that indicators in one construct will enter a different one when they are convergent. That demonstrates that, even when employed with various respondents, this instrument has a high level of consistency.

DISCUSSION

The study's ultimate output is a methodology for evaluating students who want to become science teachers' critical and creative thinking abilities on environmental challenges. Cantos et al. (2015) state that the evaluation should represent students' general aptitude, knowledge, attitudes, and skills and encourage them to reach their full potential (Kriswantoro et al., 2021). The created assessment tool must fulfill the requirements for being a reliable gauge of students' skills and competencies (Amelia & Kriswantoro, 2017; Kriswantoro et al., 2021). This instrument model was developed based on needs analysis. Namely, (1) it is necessary to develop an instrument model that can measure critical and creative thinking skills, and (2) the evaluation model can identify the areas where future science teachers' pupils need improvement.

The development stage is carried out by reviewing and synthesizing indicators of critical and creative thinking skills. Critical thinking skills refer to Ennis (1993); Fisher (2007); Johnson (2011); Scriven & Paul (2007), thus obtaining five indicators. Creative thinking skills refer to Guilford, (1956); Kaufman et al. (2008); Torrance et al. (1990); Williams (1993) in order to obtain five indicators. Thus, critical and creative thinking skills include ten indicators, namely (1) formulating problems; (2) evaluating arguments; (3) considering the credibility of the data; (4) concluding; (5) take the right decisions in solving problems; sensitivity problems; (7) fluency; (8) flexibility; (9) originality; and (10) elaboration. This indicator is synthesized by considering the material on environmental problems, and the learning steps carried out on the material.

At the time of application, this critical and creative thinking talent assessment model has passed several assessments, including qualitative analysis, validation, testing, and measurement. As previously stated, two types of model testing are done: expert testing and empirical testing using actual trials. The constructed model incorporates suitable critical and creative thinking components, according to the expert evaluation of the first design assessment model. An instrument is considered to be legitimate if the expert thinks it can measure the desired variables (Connell et al., 2018; Högberg et al., 2019; Moyano-Fuentes et al., 2019). The ten components of the development model will also be considered legitimate and acceptable in light of advice and recommendations from professionals. The experts' notes revised these comments and recommendations. After being fixed, the model may be utilized for the subsequent stage, which involves empirical testing via trials, with an Aiken index of 0.84 proving its viability. Revision I

Critical and Creative Thinking Assessment Model—Field Trials at Three Universities is the name given to these findings by the research. The analysis indicates that every ten elements have a loading factor value. The Goodness of Fit Index (GFI) and RMSEA are the criterion (Kartowagiran et al., 2020). It is generally accepted that the model acquired is fit, indicating that the instrument build is sound and may be employed in the spread of this measurement model because the values obtained fall within the necessary intervals, satisfying the Goodness of Fit requirements.

Internal validation (confirmation of components and processes) and external validation place a strong emphasis on validation (validation of the impact of using the model). Validation incorporates expert evaluation, the procedure through which the expert makes judgments about the components, structure, and potential applications. Based on defined criteria, the review procedure and evaluation inputs are created. The experts' recommendations and the data input are used to inform subsequent model modifications. This validation process may be thought of as a formative assessment. (Elwy et al., 2020; Made et al., 2022; van Groen & Eggen, 2020). The Delphi approach is employed because it is more akin to a validation procedure that involves experts evaluating and critiquing the produced model's parts and overall structure. (Kriswantoro et al., 2021). More particularly, two features of the Delphi method were quite helpful in our investigation. First, the assessment qualification contributed to this approach's success. The evaluation panel is knowledgeable in several different fields. A crucial step in the internal validation process involves experts. The first cycle, which starts with a focus group discussion (FGD), is given one week for expert reviewers to evaluate, answer multiple open-ended questions, and create the most substantial change in the model. That gives each expert a configurable time limit to score and remark. Reviewing recommendations and feedback will be crucial for the upcoming iteration.

Additional research includes more detailed empirical investigations that describe the building or improvement procedures. This study explains how the created model was made and how it was put together. First, by concentrating on several factors, this method enables completion in developing a new model with the proper degree of clarity. The model's outputs are also simple for users to understand, such as lecturers and students. Finally, this research results in a model that may be employed by lecturers who cannot be isolated from context, subject, and students and has demonstrated the validity of its content.

In order to develop one's capacity for critical thought, one must be able to deal with practical difficulties, such as assessing information and arguments in social contexts and making crucial judgments (Bailin, 1987). As a result of the frequent need for assistance in selecting, formulating, and experimentally linking data that may be used as evidence to support arguments, students usually receive relatively low scores for their capacity for critical and creative thought (Amran et al., 2019; Mahanal et al., 2019; Supena et al., 2021).

Learning and evaluation are two strategies for enhancing creative and critical thinking. The evaluation procedures utilized should be consistent with the chosen learning strategy. For instance, assessing critical and creative thinking talents might be acceptable if the learning strategy currently calls for them. It does not exclude assessments of critical and creative thinking, though, if the curriculum does not foster these skills.

Students' thinking ability is strongly influenced by the opportunities given (Runco, 1993). Compared to lecturers who only present standard projects, those who regularly provide students the chance to complete challenging work and develop their thinking abilities are more likely to foster their critical and creative thinking abilities. The significance of the lecturer's involvement in supporting students' abilities to think critically and creatively must also be on their cognitive abilities. Teachers set an example for developing pupils' critical thinking and creativity. If the teachers can think critically, they can also help develop critical learners (Munawaroh et al., 2018; Runco, 1993; Shutaleva et al., 2021; Taddeo & Tirocchi, 2021). The mentality of instructors must be changed, learning patterns in institutions that produce academic staff must be improved, and families must be supported in addition to enhancing learning patterns in all areas. Finally, educators and the community should know the proper assessment approach for each student.

Another advantage of this instrument is that it is integrated with the concept of environmental socio-scientific issues. It stimulates students to think carefully about multi-disciplinary studies, namely the content of science, technology, and social studies. Through this integration, students are stimulated to grow their critical and creative thinking in a multi-disciplinary and integrative manner about problem-solving scientifically and moral values. The ESSI framework provides a context for students to understand through carefully crafted experience that scientific knowledge is theory-laden and socially and culturally constructed (Kahn & Zeidler, 2019; Zeidler, 2015). The drawback of this instrument is that the learning process requires the application of ESSI-based learning methods. If this is done, then this instrument is easier to use.

CONCLUSION

The instrument model created for this study contains beneficial traits and qualifies as meeting the criteria needed to assess students' skills. That is demonstrated by the data analysis findings, which show that the critical and creative thinking skill instrument model satisfies the criteria for construct validity and reliability using confirmatory factor analysis from field trial data, as well as the content validity of the expert judgment. Furthermore, this instrument model has good validity and reliability because it consistently refers to the theories and indicators formulated by previous experts. However, this research has limitations, namely that it is still limited to material that is still narrow.

RECOMMENDATION

The developed instrument model can stimulate critical and creative thinking, so it is recommended to be used as a learning evaluation tool. However, the instrument model is still limited to one material on environmental problems, so it is necessary to develop other researchers to formulate other appropriate materials for learning. That is an essential point and must be done on an ongoing basis so that many things will be collected to make a bank instrument. The following researcher develops an instrument to test abilities relevant to the demands of the 21st. It is good for educators and students in particular and contributes to creating knowledge in education and learning.

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