



## Implementing Web Liveworksheet-Based Scientific Critical Creative Thinking Model to Improve Students' Thinking Skills

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| Article Info                                                                                                                                                                                                                                                                                                                                                       | Abstract                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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| <b>Article history:</b><br>Received: February 7, 2026<br>Accepted: May 26, 2026<br>Published: June 8, 2026                                                                                                                                                                                                                                                         | This study aimed to investigate the effect of the Web Liveworksheet-Based SCCrT Model on students' (1) creative thinking skills, (2) critical thinking skills, and (3) responses toward the implementation of the model in learning the basic laws of chemistry. The study employed a pre-experimental method using a one-group pretest-posttest design. The participants consisted of 35 students. Data were collected through creative and critical thinking tests and analyzed descriptively. The findings revealed that implementing the SCCrT Model improved students' creative thinking skills, as indicated by an increase in the mean score from 23.44 to 71.70. In addition, students' critical thinking skills also improved, with the mean score increasing from 32.71 to 71.14. Furthermore, students demonstrated good responses toward the implementation of the SCCrT model, with 74.51% expressing positive responses. These findings indicate that the SCCrT Model has the potential to improve students' creative and critical thinking skills in learning the basic laws of chemistry topic. |
| <b>Keywords:</b><br>Creative thinking skill<br>Critical thinking skill<br>SCCrT model<br>Web liveworksheet                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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## INTRODUCTION

Higher-order thinking skills have become a central demand in 21st-century science education. However, cultivating these skills in chemistry classrooms remains challenging because students are required to simultaneously interpret observable phenomena, connect them with symbolic and quantitative representations, and use these relationships to analyze evidence, evaluate scientific explanations, and generate alternative ideas (Senapati & Selvam, 2024; Tsaparlis, 2020). Consequently, chemistry learning should not stop at content acquisition but should also actively engage students in higher-order thinking

processes. Chemistry learning is currently dominated by procedural approaches in which students focus on memorizing formulas and fixed steps rather than understanding the scientific reasoning underlying chemical concepts. Recent studies reported that students often experience difficulties in formulating hypotheses, interpreting evidence, and connecting chemical concepts to real-world problems because classroom learning still emphasizes procedural task completion over inquiry and conceptual reasoning (Musengimana et al., 2021; Orosz et al., 2023; Stone, 2021).

This challenge is clearly visible in the basic laws of chemistry topics. Although the topic is fundamental to subsequent stoichiometric reasoning, many tenth-grade students tend to learn it procedurally, memorizing formulas or fixed steps (Putri & Latisma, 2022). Such procedural and memorization-oriented learning limits opportunities to explain why a law applies, interpret data patterns, evaluate relationships among variables, or propose more than one line of reasoning. Previous findings have reported that students often experience difficulties in interpreting experimental evidence and relating chemical data to underlying scientific principles (Orosz et al., 2023; Putri & Latisma, 2022). As a result, students' critical and creative thinking is insufficiently facilitated, even though the topic requires scientific reasoning from evidence.

Previous studies in chemistry education have mainly focused on the development of critical or creative thinking skills as separate learning outcomes, while limited attention has been given to the simultaneous development of critical and creative thinking skills as important components of higher-order thinking skills (Alkhatib, 2019). These conditions indicate the need for a learning model that actively engages students in scientific reasoning, evidence evaluation, argumentation, and idea generation to simultaneously develop critical and creative thinking skills through learning activities. One learning model that is theoretically promising to these needs is the Scientific Critical Creative Thinking (SCCrT) model. SCCrT positions learning through scientific activities while simultaneously training critical judgment and creative idea generation (Rusmansyah et al., 2023). This positioning is particularly relevant to chemistry because chemistry concepts are abstract, evidence-based, and commonly learned through the interpretation of experiments, symbols, and relationships among variables.

To facilitate higher-order thinking skills in chemistry learning, particularly on basic laws of chemistry topics, the SCCrT Model can be implemented through the use of Web Liveworksheet as an interactive web-based learning medium. SCCrT engages students in scientific activities that promote critical judgment and creative idea generation through processes such as observing phenomena, analyzing data, evaluating evidence, and formulating explanations. The use of Web Liveworksheet enables these learning activities to be implemented more interactively through multimedia content, structured tasks, immediate feedback, and flexible student participation during the learning process (Le, 2023; Lestari, 2022). To the best of our knowledge, no studies have investigated the integration of interactive web-based worksheets with learning models specifically designed to promote both critical and creative thinking in chemistry learning, particularly in the basic laws of chemistry.

Compared with conventional worksheet-based instruction, Web Liveworksheet-based SCCrT provides a more digitalized and interactive learning environment through the use of web-based activities, multimedia content, and immediate feedback during the learning process. This integration not only modernizes chemistry learning but also better supports the role of the SCCrT Model in developing scientific processes and higher-order thinking skills, as students are guided to observe phenomena, analyze data, evaluate evidence, formulate explanations, and elaborate alternative ideas in a structured learning sequence (Facione, 2015; Munandar, 2009; Rusmansyah et al., 2023). The SCCrT Model, assisted

by Live Worksheet, has been previously tested and reported in earlier studies ([Rusmansyah et al., 2025](#)), which demonstrated that the developed learning media was considered valid and feasible for chemistry learning. Based on that previous study, the present study further integrates Web Liveworksheet with the SCCrT model in chemistry learning. This integration is considered particularly relevant because Web Liveworksheet can facilitate the visualization of abstract chemistry content through interactive features and multimedia elements. Such characteristics are important in chemistry learning, especially in the basic laws of chemistry topic, where students are required to interpret relationships among variables and analyze quantitative data as well as connect observable phenomena with symbolic and conceptual representations ([Elvira & Fitriza, 2023](#)). Therefore, the integration of Web Liveworksheet with the SCCrT model is expected to better support scientific reasoning and the development of students' higher-order thinking skills. Accordingly, this study aimed to determine (1) the improvement in students' critical thinking skills, (2) the improvement in students' creative thinking skills, and (3) students' responses to the implementation of the Liveworksheet-based SCCrT model. The novelty of this study lies in integrating an interactive web-based worksheet into the SCCrT Model sequence in chemistry instruction and examining its effects on two higher-order thinking outcomes.

## METHODS

### Research Design

This study used a pre-experimental one-group pretest-posttest design ([Creswell & Creswell, 2018](#)). In this design, only one experimental group received treatment, with no comparison group. Subjects were given a pretest to measure initial abilities, followed by treatment using the Web Liveworksheet-based SCCrT model. Finally, a posttest was administered to assess the treatment's effect on students' thinking skills.

### Population and Sample

The study was conducted at SMAN 3 Banjarmasin, a public senior high school in Banjarmasin, Indonesia, during the even semester of the 2024/2025 academic year. The population consisted of all 10th-grade students. The sample consisted of 35 students aged 15 - 16 years and was selected using purposive sampling ([Creswell & Creswell, 2018](#)). In terms of gender composition, the class consisted of 18 female and 17 male students, providing a relatively balanced gender representation.

The selection of the research sample was based on several purposive sampling criteria ([Amin et al., 2023](#)), namely: (1) the students had relatively homogeneous academic ability compared to those in other classes; (2) the students possessed basic prior knowledge relevant to the topic of basic chemical laws; (3) the students demonstrated moderate levels of critical and creative thinking skills based on preliminary observations; and (4) the school permitted the group to be used as the experimental class for implementing the SCCrT Model based on live worksheets.

### Instruments

Data were collected using both test and non-test instruments. The test instruments consisted of multiple-choice questions to measure students' critical thinking skills and essay questions to assess creative thinking skills, totaling 15 items. The non-test instrument included questionnaires. The questionnaire used to measure students' responses to the intervention consisted of 10 statements and was arranged using a Likert scale ranging from 1 to 4 (1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree) ([Arikunto, 2020; Creswell & Creswell, 2018](#)).

The instruments were validated by five experts consisting of three chemistry education lecturers and two senior high school chemistry teachers based on the relevance of the questions to the learning indicators (Azwar, 2015). The results showed that all test and non-test instruments achieved validity scores ranging from 84% to 100%, indicating valid to highly valid categories. The creative thinking and critical thinking tests obtained validity scores of 84% - 88% and 88% - 96%, respectively, while the questionnaires showed scores between 84% and 100%. Instrument reliability was assessed using the KR-20 formula, which is appropriate for ordinal-scale instruments with a relatively small number of items (Fraenkel et al., 2012; Jihad & Haris, 2013). Reliability analysis results indicated that the instruments met the reliability criterion ( $\geq 0.40$ ). Furthermore, the sensitivity coefficients of the creative thinking and critical thinking tests were 0.68 and 0.59, respectively, exceeding the minimum criterion of 0.30. Therefore, all instruments were considered valid, reliable, and suitable for use in this study.

### Data Analysis Technique

The data obtained in this study were analyzed using Microsoft Excel. Descriptive statistics were employed to determine the average of students' learning outcomes before and after the implementation of the Web LiveWorksheet-based SCCRT model. In addition, students' improvements in creative and critical thinking skills were calculated using the normalized gain (n-gain) formula (Hake, 1998), and the results were categorized into low, medium, and high improvement levels based on established criteria. Furthermore, questionnaire data were analyzed using a Likert scale approach to identify students' responses to the intervention. The responses were converted into percentages and interpreted descriptively.

### Research Procedures

The research began with the preparation stage, which included developing the lesson plan based on the SCCrT model, designing Web LiveWorksheet-based learning materials, and preparing validated pre-test and post-test instruments. The second stage was the pretest, conducted to measure students' initial critical and creative thinking skills before the intervention. The third stage was the implementation of the SCCrT model integrated with Web LiveWorksheet, where students engaged in structured scientific learning activities to develop critical and creative thinking skills. The fourth stage was the posttest, administered after the intervention to measure students' improved thinking skills. In addition, students completed a response questionnaire to identify their perceptions of the learning implementation. Finally, the collected data were analyzed to determine the level of improvement in students' thinking skills.

## RESULTS AND DISCUSSION

This section presents the findings of the implementation of the Web LiveWorksheets-based SCCrT model in chemistry learning to enhance students' thinking skills. The findings are organized according to the research objectives: improvements in students' critical and creative thinking skills, and students' responses to the implementation of the learning model.

### Analysis of Students' Creative Thinking Skills

The results of the analysis of students' creative thinking skills are presented in Table 1.

Table 1 N-gain score of creative thinking skills

| Test | Score | N-gain | Category |
|------|-------|--------|----------|
| Pre  | 23.44 | 0.63   | Medium   |
| Post | 71.70 |        |          |

Table 1 generally shows that students' creative thinking skills increased after treatment. The average score improved from 23.44 in the pretest to 71.70 in the posttest, indicating higher overall performance after the learning process. Furthermore, the obtained n-gain score was categorized as medium. These results show an increase in students' creative thinking skills following the implementation of the learning. Specifically, the results of the analysis of students' creative thinking skills for each indicator are presented in Table 2.

Table 2 N-gain score of creative thinking skill for each indicator

| Indicators     | Pretest      | Posttest     | n-gain      |
|----------------|--------------|--------------|-------------|
| Fluency        | 24.57        | 75.42        | 0.67        |
| Flexibility    | 24.00        | 63.42        | 0.51        |
| Originality    | 22.85        | 69.14        | 0.60        |
| Elaboration    | 22.34        | 78.85        | 0.72        |
| <b>Average</b> | <b>23.44</b> | <b>71.70</b> | <b>0.63</b> |

Table 2 shows that elaboration achieved the highest n-gain score in the high category, while fluency, originality, and flexibility were categorized as medium. These findings indicate that the learning process positively improved all indicators of students' creative thinking skills, with the greatest improvement occurring in the elaboration aspect.

#### Analysis of Students' Critical Thinking Skills

The results of the analysis of students' critical thinking skills are presented in Table 3.

Table 3 N-gain score of critical thinking skills

| Test | Score | n-gain | Category |
|------|-------|--------|----------|
| Pre  | 32.71 | 0.57   | Medium   |
| Post | 71.14 |        |          |

Table 3 shows students' critical thinking skills increased after treatment. The average score improved from 32.71 in the pretest to 71.14 in the posttest. Furthermore, the obtained n-gain score was categorized as medium. These results show an increase in students' critical thinking skills following the learning implementation. Specifically, the results of students' critical thinking skills analysis for each indicator are presented in Table 4.

Table 4 N-gain score of critical thinking skills for each indicator

| Indicators     | Pretest      | Posttest     | n-gain      |
|----------------|--------------|--------------|-------------|
| Focus          | 44.28        | 82.85        | 0.69        |
| Reason         | 33.56        | 75.71        | 0.63        |
| Inference      | 26.42        | 67.85        | 0.56        |
| Situation      | 22.99        | 63.57        | 0.47        |
| Clarity        | 37.14        | 71.42        | 0.54        |
| Overview       | 21.42        | 60.00        | 0.49        |
| <b>Average</b> | <b>32.71</b> | <b>71.14</b> | <b>0.57</b> |

Table 4 shows that focus achieved the highest n-gain score in the medium category, followed by reason, inference, clarity, overview, and situation, which were also categorized as medium. These findings indicate that the learning process moderately improved all indicators of students' critical thinking skills, with the greatest improvement occurring in the focus aspect.

#### Analysis of Students' Responses to the Implementation of the LiveWorksheet-Based SCCrT Model

The results of students' responses toward the implementation of the Liveworksheet-based SCCrT Model are presented in Table 5.

Table 5 Percentage of students' responses

| No       | Aspect                                                | %     |
|----------|-------------------------------------------------------|-------|
| 1        | Learning attractiveness                               | 78.28 |
| 2        | Conceptual understanding                              | 75.42 |
| 3        | Learning motivation                                   | 73.14 |
| 4        | Concept connection                                    | 71.42 |
| 5        | Active participation                                  | 78.86 |
| 6        | Problem-solving ability                               | 72.57 |
| 7        | Team collaboration                                    | 79.42 |
| 8        | Communication confidence                              | 74.85 |
| 9        | Critical and creative thinking improvement            | 69.71 |
| 10       | Suitability of the SCCrT Model for chemistry learning | 76.00 |
| Average  |                                                       | 74.51 |
| Category |                                                       | Good  |

The average percentage of students' responses was 74.51%, which was categorized as "Good." This finding indicates that students responded positively to the intervention in learning basic chemical laws.

### The Relationship of The Web Liveworksheet-based SCCrT Model to Improve Creative and Critical Thinking Skills

The implementation of the SCCrT model, supported by web-based live worksheets, has improved students' creative and critical thinking skills. This improvement can be explained by integrating constructivist learning principles, structured inquiry processes, and digital scaffolding. From a constructivist perspective, knowledge is actively constructed through engagement, interaction, and reflection (Wittrock, 2010). The SCCrT model facilitates this process by guiding students through structured stages, including problem identification, reasoning, analysis, and evaluation. These stages require students to actively process information and construct meaning, which are essential for the development of higher-order thinking.

The mechanism of the LiveWorksheet contribution lies in its role as an interactive digital scaffold. LiveWorksheets provide structured tasks, immediate feedback, and multimedia representations that help students explore concepts and refine their understanding iteratively. This enables students to engage in self-regulated and reflective learning processes, which are critical for both creative and critical thinking. Recent studies indicate that LiveWorksheet-based learning enhances students' thinking skills by promoting interactive engagement and problem-solving activities (Putri & Wulandari, 2023; Sari, 2022). In addition, LiveWorksheets supports an interactive learning environment characterized by active participation and sustained cognitive engagement. Students are required to analyze problems, discuss ideas, and evaluate solutions, which simultaneously activate creative and critical thinking processes. Digital worksheet-based learning has been shown to improve higher-order thinking by facilitating structured and interactive learning experiences (Niswah & Dewi, 2024; Putri & Wulandari, 2023).

The selection of basic laws of chemistry as the focus of this study was considered appropriate for implementing the Web Liveworksheet-based SCCrT model because these concepts require students to engage in analytical, critical, and logical reasoning processes. These concepts are fundamental, requiring students to understand relationships between variables and apply logical reasoning to solve problems (Lestari, 2022; Tari & Rosana, 2019). Moreover, they are closely related to observable phenomena, enabling students to connect abstract concepts with real-life contexts. This characteristic makes them

particularly suitable for science-based and problem-oriented learning, which supports the development of higher-order thinking.

From a practical perspective, these findings suggest that teachers should integrate structured thinking models and interactive digital tools to support the development of 21st-century skills. The SCCrT model, combined with the LiveWorksheet, provides a feasible approach for implementing technology-integrated learning and curriculum innovation, particularly in science education. In practical implementation, these findings indicate that teachers need to design learning activities that provide students with opportunities to actively discuss, analyze problems, express ideas, and reflect on their reasoning during the learning process. Schools and educators should also consider providing adequate technological support and learning resources to ensure effective classroom implementation. In addition, integrating structured learning models with digital platforms can serve as an alternative strategy to increase student participation, promote more active learning experiences, and support the achievement of learning objectives oriented toward higher-order thinking skills in 21<sup>st</sup>-century education.

### **Students' Creative Thinking Skills**

Creative thinking skills are mental processes that involve generating new ideas, transforming existing ones, and devising original solutions to problems. [Almeida et al. \(2008\)](#) explain that four main components underlie creative thinking: fluency in generating many ideas, flexibility in seeing from multiple perspectives, originality in generating ideas, and elaboration in enriching and developing existing ideas. These four aspects serve as important benchmarks for evaluating a person's creative thinking. In the learning process, developing these skills is essential for cultivating innovative, responsive students who can address complex problems.

The results showed an improvement in students' creative thinking skills after implementing the SCCrT model assisted by the Web Liveworksheet platform. The average pretest score increased from 23.44 to 71.70 in the posttest, indicating that the learning model positively influenced students' ability to express ideas constructively. The SCCrT Model provided structured opportunities for students to explore, evaluate, and develop innovative solutions through problem-oriented activities. This finding supports the view of [Jia et al. \(2025\)](#) that creative thinking development is closely related to a strong creative mindset fostered through active learning experiences.

Improvements occurred across all creative thinking indicators. Fluency increased from 24.57 to 75.42 (N-gain = 0.67), indicating that students became more capable of generating multiple relevant ideas related to the law of conservation of mass. Students with high scores were able to provide logical and scientifically appropriate explanations, while low-scoring students still struggled to convey ideas systematically. Flexibility also improved from 24.00 to 63.42 (N-gain = 0.51), showing that students became more accustomed to analyzing problems from different perspectives and developing arguments based on evidence and relevant literature. Students with low scores experienced difficulties in applying concepts to different situations and constructing varied perspectives based on scientific reasoning.

Originality increased from 22.85 to 69.14 (N-gain = 0.60). Students demonstrated better ability to formulate unique ideas and connect the law of definite proportions to real situations. However, some students still produced conventional responses and had difficulty presenting novel ideas. Elaboration showed the highest improvement, increasing from 22.34 to 78.85 (N-gain = 0.72). Students became more capable of constructing detailed and logical explanations regarding the relationships between gas pressure, volume, temperature, and safety factors. The structured stages of the SCCrT model and guided

activities in Web Liveworksheet helped students organize and expand their ideas systematically.

Among all indicators, elaboration achieved the highest improvement because the learning activities provided continuous guidance through prompts, discussions, and step-by-step responses that supported detailed explanations. In contrast, flexibility showed the lowest improvement because viewing problems from multiple perspectives and constructing evidence-based reasoning require strong analytical and adaptive thinking skills. Although the SCCrT Model encouraged students to analyze information and develop arguments, many students still experienced difficulties in applying concepts to different situations and generating varied approaches to problem-solving. This finding indicates that flexibility requires sustained practice and deeper conceptual understanding to develop optimally.

### **Students' Critical Thinking Skills**

Critical thinking is a conscious, active, and directed thinking process that involves conceptualizing ideas, applying knowledge, analyzing information, synthesizing data, and evaluating situations logically. According to [Ennis \(2011\)](#), critical thinking consists of six characteristics summarized in the FRISCO framework: focus, reason, inference, situation, clarity, and overview. The findings of this study revealed an improvement in students' critical thinking skills. This result supports previous studies showing that the SCCrT Model effectively develops students' critical thinking skills through systematic learning stages that encourage deep and logical thinking ([Anisah & Carlian, 2020](#)).

Rather than discussing each FRISCO indicator separately, the findings can be synthesized into three core components of critical thinking: reasoning, inference, and evaluation. The reasoning component includes the indicators of focus, reason, and clarity. The results showed that this component experienced the greatest improvement. Focus increased from 44.28 to 82.85 with an n-gain of 0.69, reason increased from 33.56 to 75.71 with an n-gain of 0.63, and clarity improved from 37.14 to 71.42 with an n-gain of 0.54. These findings indicate that students became more capable of identifying core problems, constructing logical arguments, and expressing their ideas clearly. The improvement was closely related to the structured stages of the SCCrT model, which continuously trained students to identify problems, analyze information, and justify their answers using evidence and relevant facts ([Rusmansyah et al., 2023](#)). The use of contextual problems related to the basic laws of chemistry also supported students in connecting scientific concepts with real-life situations, making learning more meaningful ([Putri & Latisma, 2022](#)).

The inference component represents students' ability to draw logical conclusions based on available evidence and information ([Din & Ghani, 2019](#)). The inference score increased from 26.42 to 67.85, with an n-gain of 0.56. This improvement suggests that students became more skilled at linking information, formulating hypotheses, and generating conclusions consistent with their arguments. Students with high scores demonstrated the ability to construct logical and convincing conclusions, indicating that they were able to connect evidence and reasoning effectively. This finding supports the idea that critical thinking is not limited to analyzing information but also involves making sound judgments and decisions based on logical reasoning ([Din & Ghani, 2019](#); [Ennis, 2011](#); [Linda & Richard, 2002](#)).

The evaluation component consists of the situation and overview indicators. The situation improved from 22.99 to 63.57 with an N-gain of 0.47, while the overview increased from 21.42 to 60.00 with an n-gain of 0.49. Although both indicators showed moderate improvement, the results were lower than those of the reasoning component. This suggests that students still experienced difficulties in evaluating problems

comprehensively, considering contextual factors, and reviewing their overall thinking processes. Nevertheless, the learning activities encouraged students not to accept information directly but to reflect on evidence, examine different perspectives, and evaluate the appropriateness of their conclusions.

### **Student Responses to the LiveWorksheet-based SCCrT Model**

Analysis of students' responses toward the intervention showed that the highest positive response was observed in the aspect of team collaboration. This result indicates that the SCCrT model encouraged students to work together during learning activities. Collaborative learning activities allowed students to exchange ideas, discuss concepts, and solve problems collectively (Koivuniemi et al., 2018). The use of Web Liveworksheet also facilitated group interaction because students could complete tasks systematically and engage in discussions more effectively (Le, 2023). This finding aligns with the characteristics of student-centered learning, which emphasize communication and collaboration during the learning process. High positive responses were also obtained in the aspects of active participation and learning attractiveness. Students perceived that implementing the SCCrT model made learning chemistry more interesting and enjoyable. The integration of Web LiveWorksheets as a digital learning medium likely contributed to increasing students' attention and engagement during instruction. Interactive learning activities can reduce monotonous classroom situations and encourage students to become more actively involved in learning activities (Vercellotti, 2017).

In the cognitive aspect, the responses related to conceptual understanding, concept connection, and problem-solving ability also showed positive results. These findings indicate that the SCCrT model helped students understand basic chemical laws more effectively. Through structured learning activities, students were encouraged to connect prior knowledge to newly learned concepts and apply their understanding to solve problems. In addition, the improvement in critical and creative thinking received a relatively positive response, suggesting that the learning activities provided opportunities for students to analyze and evaluate problems critically. Positive responses were also found in learning motivation, communication confidence, and the suitability of the SCCrT model for chemistry learning. Overall, these findings demonstrate that implementing the Web Liveworksheet-based SCCrT model positively contributed to students' learning experiences and supported more active, collaborative, and meaningful chemistry learning processes.

### **CONCLUSION**

The implementation of the SCCrT model, supported by web-based live worksheets, is associated with improvement in students' creative and critical thinking skills. This improvement is reflected in the difference between pretest and posttest scores. Students' creative thinking skills increased from an average score of 23.44 to 71.70, while critical thinking skills improved from 32.71 to 71.14. These results indicate higher student performance after the learning intervention. In terms of indicators, all aspects of creative thinking improved, with elaboration showing the greatest increase. Similarly, critical thinking skills improved across key components, particularly in reasoning, inference, and evaluation, indicating stronger abilities to analyze problems, draw conclusions, and evaluate information. Student responses to the implementation of the SCCrT Model were also positive, with 74.51% of students agreeing with its use, indicating a favorable perception of the learning process. The role of LiveWorksheets contributes to these improvements by providing interactive and structured digital tasks, immediate feedback, and multimedia support. These features facilitate active participation, support self-regulated learning, and enable students to refine their understanding through iterative processes. As a result, students are more engaged in analyzing problems and developing

ideas, which supports both creative and critical thinking skills. Overall, integrating the SCCrT Model with the LiveWorksheet offers a promising approach to promoting higher-order thinking skills and supporting technology-integrated learning in science education.

#### **CONFLICT OF INTEREST**

The authors declare that there is no conflict of interest.

#### **AUTHOR CONTRIBUTIONS STATEMENT**

Pia Asti Puspasari and Rusmansyah played a major role in the conceptualization stage of the research, from formulating ideas and objectives to guiding the study. Rusmansyah was also responsible for developing the research methodology used. Formal analysis of the research data was conducted by Pia Asti Puspasari, with support from scientific discussions with the other authors. Pia Asti Puspasari entirely drafted the initial version of the article. Furthermore, Nurlaila Hayati contributed to the manuscript design and development. At the same time, the other authors, namely Muhsinah Annisa, Arief Ertha Kusuma, Asmi Rusmanyanti, Nasrullah, and Tien Tien Lee, contributed to the critical review, refinement of the substance, and academic validation based on their respective expertise in education, language, and learning technology. All authors have made substantial contributions to this scientific work and approved the final version of the manuscript for publication.

#### **AI DISCLOSURE STATEMENT**

The author used Grammarly, Mendeley, and Turnitin during the preparation of this work for language checking, reference management, citation formatting, bibliography organization, and similarity screening. After using these tools, the author thoroughly reviewed, edited, and verified the manuscript as needed and takes full responsibility for the content of the publication. The authors declare that no generative artificial intelligence (AI) tool was used to create, analyze, interpret, or write the scientific content of this research.

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