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Effectiveness of an Ethnoscience-Based TAPPS Model Using Aromatherapy Incense Context on Students' Written Communication Skills in Learning Elements, Compounds, and Mixtures

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Abstract: This study investigated the effectiveness of the ethnoscience-based Think Aloud Pair Problem Solving (TAPPS) model using aromatherapy incense to improve junior high school students' written communication skills on elements, compounds, and mixtures. The novelty of this study lies in using aromatherapy incense as an authentic ethnoscience context that connects local cultural practices with scientific concepts. A quasi-experimental pretest–posttest nonequivalent control group design was employed. Two intact eighth-grade classes were selected through cluster random sampling, with Class VIII A (31 students) assigned as the experimental group and Class VIII B (31 students) as the control group. The intervention was conducted over five meetings within three weeks. Data were analyzed using an Independent Samples *t*-test and Cohen's *d*. The experimental group achieved significantly higher written communication skills than the control group, with a large effect size (Cohen's $d = 0.747$), indicating the effectiveness of the proposed learning model.

Keywords: TAPPS, ethnoscience, written communication skills, science learning

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1. Introduction

21-century education demands that students possess communication, collaboration, critical thinking, creativity, and the ability to relate scientific concepts to real life (Bernhardt, 2015). Global developments in the Industrial Revolution 4.0 era also drive educational transformation toward more innovative, contextual, and technology-based learning (Kolesnichenko et al., 2018; Elayyan, 2021). In science learning, written communication skills are essential because they enable students to present scientific ideas, explain experimental findings, and construct evidence-based conclusions in a clear, structured, and logical manner (Khromchenko, 2024). In addition to serving as a means of expressing ideas, writing activities also support the development of students' knowledge and scientific reasoning (Chen et al., 2013). However, students' written communication skills in science learning remain relatively low. A preliminary observation conducted at SMP Negeri 6 Surakarta indicated that many students experienced difficulties in organizing experimental reports systematically, using appropriate scientific terminology, and explaining experimental results based on scientific evidence. Interviews with the science teacher also revealed that students' laboratory reports were often incomplete and lacked coherent scientific explanations. These limitations are influenced by teacher-centered learning practices that reduce students' active engagement in the learning process (Treve, 2024). Furthermore, students' written communication skills are often limited to technical aspects such as spelling and sentence construction and have not yet developed into the ability to communicate scientific ideas in a reflective and meaningful manner (Das, 2014).

Science learning also tends to emphasize cognitive achievement without sufficiently connecting scientific concepts to students' cultural backgrounds and everyday experiences (Yulianci et al., 2021; Deta et al., 2020). In contrast, the Independent Curriculum highlights the importance of contextual learning that links academic concepts with real-life situations (Simarmata et al., 2023). One approach that can support this objective is ethnoscience, which integrates local knowledge and culture into science learning (Botha, 2012). Ethnoscience-based learning enables students to understand scientific concepts through cultural contexts that are familiar to their daily lives while simultaneously fostering appreciation for local culture (Fasasi, 2017). In this study, ethnoscience was implemented through the production of aromatherapy incense, as its raw materials represent elements, compounds, and mixtures, while the mixing and combustion processes illustrate physical and chemical changes that are closely related to the learning topic. The Think Aloud Pair Problem Solving (TAPPS) model was selected because it

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encourages students to verbalize their thinking processes and collaborate in solving problems (Simpol et al., 2017).

Previous studies have demonstrated that the Think Aloud Pair Problem Solving (TAPPS) model effectively improves students' problem-solving skills, communication skills, and active participation during learning activities (Simpol et al., 2017). Likewise, ethnoscience-based learning has been widely reported to enhance students' conceptual understanding and promote meaningful learning by connecting scientific concepts with local cultural practices (Fasasi, 2017; Yulianci et al., 2021). However, only a few studies have integrated the TAPPS model with an ethnoscience approach to improve students' written scientific communication, particularly in experimental report writing (Khromchenko, 2024). Furthermore, the use of aromatherapy incense as an ethnoscience learning context for teaching elements, compounds, and mixtures has received little attention. The production of aromatherapy incense

Involves the identification of elements, compounds, mixtures, and physical and chemical changes, making it an authentic context for learning these concepts. In this study, students explored these scientific concepts through the TAPPS stages of understanding problems, discussing solution strategies, verbalizing their reasoning, and collaboratively solving problems before communicating their findings in written experimental reports (Simpol et al., 2017). These learning activities were expected to strengthen students' ability to write effective introductions, formulate clear objectives, organize reports coherently, and use appropriate scientific language, all of which are essential components of written scientific communication (Chen et al., 2013; Khromchenko, 2024). Therefore, the novelty of this study lies in integrating the TAPPS model with aromatherapy incense as an ethnoscience learning context to improve junior high school students' written communication skills on the topic of elements, compounds, and mixtures. Accordingly, the independent variable of this study was the ethnoscience-based TAPPS model using aromatherapy incense, while the dependent variable was students' written communication skills.

Based on this framework, the research hypothesis states that the ethnoscience-based TAPPS model using aromatherapy incense significantly improves students' written communication skills on the topic of elements, compounds, and mixtures. Therefore, this study aimed to determine the effectiveness of the ethnoscience-based TAPPS model using aromatherapy incense in improving junior high school students' written communication skills.

2. Method

This research was conducted at SMP Negeri 6 Surakarta from February to March 2026 during the second semester of the 2025/2026 academic year using a quantitative approach with a quasi-experimental method and a Pretest–Posttest Nonequivalent Control Group Design (Schutt, 2019). The study involved 62 eighth-grade students, comprising 31 students in the experimental group (Class VIII A) and 31 students in the control group (Class VIII B). The independent variable was the ethnoscience-based Think Aloud Pair Problem Solving (TAPPS) model utilizing aromatherapy incense, while the dependent variable was students' written communication skills on the topic of elements, compounds, and mixtures.

The population consisted of all 242 eighth-grade students of SMP Negeri 6 Surakarta in the 2025/2026 academic year. The samples were class VIII A as the experimental group and class VIII B as the control group, selected using cluster random sampling (Buchstaller et al., 2013). Prior to sample selection, normality and homogeneity tests were conducted to ensure that the population data were normally distributed and homogeneous. The experimental class was taught using the ethnoscience-based TAPPS model utilizing aromatherapy incense, while the control class received conventional learning.

The research instruments consisted of an experimental report assessment rubric and an observation sheet. The experimental report rubric was used to assess students' written communication skills before and after the intervention through pretest and posttest experimental reports, while the observation sheet was used to monitor the implementation of the learning activities. The rubric consisted of 10 indicators: effective introduction, main objectives and ideas, student presents results and well founded, conclusions appropriate and concise, report clear, structured and coherent, formal style and format, grammar (orthography), appropriate technical language, discuss and justifies the information presented, and uses graphical resources in an effective way, giving quality to the report (Sonseca et al., 2015). Each indicator was scored using a six-point rating scale ranging from 0 (lowest performance) to 5 (highest performance), and the total score was converted to a 0–100 scale. The scoring descriptors assessed the completeness, coherence, scientific accuracy, organization, language quality, and presentation of students' experimental reports. Content validity was established using Gregory's formula, yielding a validity coefficient of 0.85, indicating high content validity (Knapp et al., 2010; Sudaryono et al., 2019). Instrument reliability was evaluated using Cronbach's Alpha, resulting in a coefficient of 0.845, indicating good internal consistency and confirming that the rubric was reliable for assessing students' written communication skills (Kimberlin et al., 2008).

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Data were analyzed using descriptive and inferential statistics. Prior to hypothesis testing, the assumptions of normality and homogeneity were examined using the Shapiro–Wilk and Levene's tests, respectively. The Shapiro–Wilk test indicated that the pretest and posttest scores in both the experimental and control groups were normally distributed (pretest: p = 0.166 and 0.101; posttest: p = 0.407 and 0.059; p > 0.05). In addition, Levene's test showed homogeneous variances for both the pretest (p = 0.260) and posttest (p = 0.727), confirming that the data met the assumptions required for parametric analysis. Therefore, an Independent Samples t-test was performed to compare students' written communication skills between the experimental and control groups (Marisya, 2023; Ross et al., 2017). Statistical significance was determined at the 0.05 level. Furthermore, Cohen's d was calculated to evaluate the magnitude of the treatment effect (Safitri et al., 2021).

3. Result and Discussion

Result

Students' written communication skills data were obtained from the assessment of pre- and post-learning experimental reports in both the experimental and control classes. A description of the data is presented in Table 1.

Table 1. Written Communication Skills Assessment Instrument Data

Description	Experimental Class		Control Class	
	Pretest	*Posttest*	*Pretest*	*Posttest*
Avarage	48	68	45	57
Std. Deviation	10.928	12.288	8.850	13.899
Score Max	64	90	58	80
Score Min	26	46	28	28

Based on Table 1, the average score of students' written communication skills in the experimental class increased from 48 on the pre-learning experimental report to 68 on the post-learning experimental report. Similarly, the control class showed an increase from 45 to 57. The gain score in the experimental class was 20 points, which was higher than that of the control class (12 points). Furthermore, the maximum score in the experimental class increased from 64 to 90, whereas the control class improved from 58 to 80. These results indicate a greater improvement in students' written communication skills in the experimental class compared to the control class.

To provide a more detailed description of students' written communication skills, improvements in each assessment indicator are presented in **Table 2**.

Table 2. Students' Mean Scores on Written Communication Skill Indicators

Description	Experimental Class		Control Class	
	Pretest	*Posttest*	*Pretest*	*Posttest*
Effective introduction	1.86	2.68	1.89	1.75
Main objectives and ideas	1.86	3.17	1.86	1.89
Student presents and well founded	2.79	3.17	2.51	3.03
Conclusions appropriated and concise	1.20	2.82	1.31	1.58
Report clear structured and coherent	2.03	3.93	2.72	3.55
Formal style and format	3.93	4.20	3.51	4
Grammar	1.72	3.51	1.86	3.13
Appropriate technical language	2.06	2.93	1.75	3.44
Discuss and justrifies the information presented	2.34	2.96	2.37	2.86
Uses graphical resources in effective way	4.17	4.17	2.86	3.41

As presented in Table 2, the experimental group demonstrated higher mean scores than the control group across all written communication indicators after the intervention. Improvements were observed in all indicators, indicating that the ethnoscience-based TAPPS model contributed to enhancing various aspects of students' written communication skills.

To determine whether the difference in students' written communication skills between the experimental and control groups was statistically significant, an Independent Sample t-test was conducted using the post-learning experimental report scores. The results of the analysis are presented in Table 3.

Table 3. Independent Sample t-Test Results

Source	*Sig. (2-tailed)*	*t- count*	*t- table*	*Test Decision*
Post-Experimental and Control Class Reports	0.006	2.843	2.003	Significant difference H_0 rejected

Based on Table 3, Levene's test indicated that the assumption of homogeneity of variances was satisfied (p = 0.727); therefore, the equal variances assumed results were interpreted. The Independent Samples t-test revealed a statistically significant difference in students' written communication skills between the experimental and control groups, $t(56)$ = 2.843, p = 0.006. The mean difference between the two groups was 9.793 (SE = 3.445), with a 95% confidence interval ranging from 2.892 to 16.694. These findings indicate that students who learned through the

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ethnoscience-based Think Aloud Pair Problem Solving (TAPPS) model using aromatherapy incense achieved significantly higher written communication skills than those who received conventional instruction. Accordingly, the null hypothesis (H_0) was rejected, whereas the alternative hypothesis (H_1) was accepted.

To determine the magnitude of the effect of the learning model on students' written communication skills, an effect size analysis was conducted using Cohen's d based on the post-learning experimental report scores of both groups. The results are presented in Table 4.

Table 4. Effect Size Test Results

Class	*Effect Size (Cohen's d)*	*Criteria*
Experimental and Control	0.747	Large

Based on Table 4, the effect size analysis yielded a Cohen's *d* value of 0.747, which is categorized as a large effect according to the interpretation guidelines proposed by Sommet et al. (2023).

Discussion

Written communication skills in this study were measured using students' experimental reports based on several indicators, namely effective introduction, main objectives and ideas, report clear, structured and coherent, appropriate technical language, and grammar. These indicators reflect students' ability to communicate scientific ideas systematically, accurately, and logically in written form (Sonseca et al., 2015).

The results showed that the average score of students' written communication skills in the experimental class increased from 48 to 68, while the control class increased from 45 to 57. The experimental class showed a greater improvement of 20 points compared to 12 points in the control class. Furthermore, the Independent Sample t-test revealed a significance value of 0.006 (< 0.05), indicating a significant difference in written communication skills between students who learned using the ethnoscience-based TAPPS model and those who learned through conventional instruction. The effect size analysis also produced a Cohen's d value of 0.747, which was categorized as large. These findings indicate that the ethnoscience-based TAPPS model had a substantial effect on improving students' written communication skills.

The higher written communication scores achieved by the experimental group may be associated with the integration of the TAPPS model and aromatherapy incense as an ethnoscience learning context. Throughout the learning process, students were encouraged to verbalize their thinking, discuss ideas with peers, and

organize information systematically before presenting it in written experimental reports. These learning activities were reflected in improvements across several assessed indicators, particularly effective introduction, main objectives and ideas, report clear, structured and coherent, appropriate technical language, and discuss and justifies the information presented. Furthermore, the ethnoscience context enabled students to relate scientific concepts to familiar cultural practices, making scientific explanations more meaningful and better organized. These findings are consistent with the implementation of the ethnoscience-based TAPPS syntax, including material delivery, grouping, understanding the problem, planning a solution, solving the problem, and role-swapping, which provided students with repeated opportunities to communicate, evaluate, and refine their ideas before expressing them in written form.

In the material delivery stage, the teacher delivers material and motivates students through contextual questions related to the phenomenon of burning aromatherapy incense. This stage helps students connect everyday experiences with the science concepts being studied. According to Piaget, this process demonstrates assimilation when students begin to link new information with prior knowledge (Piaget, 1976). Furthermore, the teacher's prompting questions serve as scaffolding, helping students gradually understand concepts within the zone of proximal development (ZPD) (Vygotsky, 1978). The impact is evident in the effective introduction indicator, where before the lesson, students still struggled to develop a contextually appropriate introduction. After the lesson, students began to write introductions that were clearer and more relevant to the experimental phenomenon. These findings are consistent with the argument of Elias et al. (2025), who stated that providing contextual questions at the beginning of learning increases student engagement and helps students organize their initial ideas more systematically. This process enables students to develop clearer and more structured written reports. Similarly, Atmojo et al. (2023) reported that contextual learning improves students' ability to express scientific ideas in writing because they can more easily understand concepts that are connected to real-life experiences.

In the grouping stage, students are divided into heterogeneous groups and engage in discussions using student worksheets (LKPD) and ethnoscience-based booklets. Group discussions provide opportunities for students to exchange ideas, express opinions, and refine their understanding through social interaction. According to Vygotsky, social interaction is a crucial factor in cognitive development because students learn through peer assistance within the ZPD (Vygotsky, 1978). Pairwork activities in the TAPPS model also train students to alternately act as problem solvers and listeners, thus developing communication skills through the

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process of explaining and listening. This impacts formal style and format indicators, where students begin to be able to compile reports with a more complete format and use more formal language than before the lesson. Pair discussions in the TAPPS model help students more actively express ideas and improve communication skills. Research by Pratiwi et al. (2022) also shows that group discussion activities and recording discussion results can help students organize information in a more structured and systematic way in written form.

In the understanding the problem stage, students are guided to understand the problem through images and information presented in an ethnoscience-based booklet. This stage helps students identify the concepts of elements, compounds, and mixtures involved in the production and combustion of aromatherapy incense. From Piaget's perspective, students experience an assimilation process by connecting the observed phenomena with their prior knowledge (Piaget, 1976). The booklet also functions as scaffolding that helps students understand the problem in a more focused manner (Vygotsky, 1978). This process contributed to improvements in the main objectives and ideas and appropriate technical language indicators. Before the intervention, students had difficulty formulating experimental objectives and using scientific terms accurately. After the intervention, they were able to formulate clearer objectives and appropriately use scientific terms such as elements, compounds, mixtures, H_2O, and CO_2. These findings are consistent with Mayani et al. (2023), who reported that the use of contextual learning media helps students understand scientific terminology and reduces errors in the use of scientific language in laboratory reports. Similarly, Putra (2021) showed that an ethnoscience approach helps students understand scientific concepts through cultural phenomena that are closely related to everyday life.

In the planning a solution stage, students systematically organized the tools, materials, and experimental procedures with the support of the ethnoscience-based booklet. This stage reflects the accommodation process, in which students modified their existing knowledge structures based on new information acquired during learning (Piaget, 1976). Bruner (1996) argued that learning becomes more meaningful when students actively discover and construct their own knowledge. Accordingly, organizing experimental procedures helped students understand the sequence of activities more logically and systematically.

The impact is seen in the clearly structured and coherent report indicator, where before the learning process, students were unable to organize the tools, materials, and work procedures sequentially. After the learning process, students began to be able to compile reports with a clearer, more complete structure, and interconnected sections. These results are supported by research by Atmojo et al.

(2023), which showed that active, experiment-based learning helps students compile scientific reports in a more coherent and sequential manner. Research by Das (2014) also states that good written communication is characterized by the ability to organize information systematically and easily understood.

In the solving stage, students conduct experiments, analyze data, and present results in tables and graphs. This stage trains students to actively process data and communicate observations in writing. According to Piaget, this process indicates equilibration, which is the balancing of prior knowledge and new information, resulting in more stable understanding (Piaget, 1976). The think-aloud activity in the TAPPS model helps students verbally express their thought processes before writing them down. This impacts the indicators of students presenting results and being well-founded, using graphical resources effectively, and discussing and justifying the information presented. Before the lesson, students still had difficulty presenting complete results and were unable to connect data with scientific concepts. After the lesson, students began to be able to present experimental results more systematically, create neater tables, and provide explanations supported by scientific reasons. These results align with research by Sasmito et al. (2017) which states that active learning based on practicums can improve students' ability to convey and explain observational results. Research by Rahmadani et al. (2026) also showed that data interpretation and scientific discussion activities help students develop evidence-based scientific argumentation and communication skills.

In the role swap stage, students switch roles between problem solver and listener, giving each student the opportunity to explain and evaluate their understanding. This stage helps students correct writing errors and clarify conceptual understanding through feedback from discussion partners. According to Vygotsky, this process demonstrates a shift from the ZPD to independent abilities through internalization of discussion outcomes (Vygotsky, 1978). Furthermore, Bruner explained that learning support can be gradually reduced so that students become more independent in constructing knowledge (Bruner, 1996). The impact is evident in indicators of grammar and conclusions that are appropriate and concise. Before the lesson, students still made many spelling errors and drew conclusions that did not align with the experimental results. After the lesson, students began to write with better grammar and drew conclusions that were more logical and aligned with the experimental data. These findings are supported by research by Sonseca et al. (2015), which states that good written communication skills are characterized by the use of grammar, report structure, and conclusions that are consistent with scientific data. Research by Pratiwi et al. (2022) also shows that

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revision and discussion among students help improve the quality of students' scientific writing.

Science teachers by offering a contextual learning strategy that actively engages students in discussing, reasoning, and communicating scientific ideas through written experimental reports. The ethnoscience-based booklet can be used as a learning guide to help students connect the concepts of elements, compounds, and mixtures with the local context of aromatherapy incense production without requiring students to burn incense in the classroom. Instead, teachers may utilize photographs, videos, prepared samples, or teacher demonstrations to ensure a safe learning environment while maintaining the authenticity of the ethnoscience context. This approach enables students to develop scientific communication skills through meaningful and culturally relevant learning experiences. These findings are consistent with Melawati et al. (2022) and Jufrida et al. (2024), who reported that the TAPPS model and ethnoscience-based learning improve students' communication skills and conceptual understanding through collaborative discussion, verbal reasoning, and contextual learning.

4. Conclusion

Based on the results and discussion, it can be concluded that the ethnoscience-based Think Aloud Pair Problem Solving (TAPPS) model using aromatherapy incense effectively improved the written communication skills of eighth-grade students at SMP Negeri 6 Surakarta on the topic of elements, compounds, and mixtures. This conclusion is supported by the hypothesis test, which showed a significant difference between the experimental and control groups ($p = 0.006$), as well as the effect size analysis, which yielded a Cohen's d value of 0.747, indicating a large effect. These findings suggest that integrating ethnoscience contexts into the TAPPS model can serve as an effective instructional strategy for enhancing students' written scientific communication in science learning and may be adopted by science teachers to provide more contextual and meaningful learning experiences. However, this study was limited by its relatively small sample size and its implementation in only one junior high school, which may restrict the generalizability of the findings. Therefore, future research is recommended to involve larger and more diverse samples and to explore the application of the ethnoscience-based TAPPS model in different ethnoscience contexts and science topics.

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