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Ethno-STEM-Based Science Learning Using Typical Foods of Sidoarjo to Improve Science Literacy among Junior High School

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Abstract : *The low level of science literacy among junior high school students indicates the need for contextual and meaningful learning. Therefore, this research aims to determine the effect of Etno-STEM-based science learning on Sidoarjo's typical foods on junior high school students' science literacy. This research used a one-group pretest-posttest design with purposive sampling. The subjects of this study were 20 eighth-grade students at a junior high school in Sidoarjo Regency. The research instrument consisted of 15 multiple-choice questions based on three indicators of science literacy, namely explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically. The pretest and posttest data were analyzed using the N-Gain test and paired t-test to determine the level of improvement and the significance of the difference in students' science literacy skills. The N-Gain analysis showed a value of 0.89 for the indicator of explaining phenomena scientifically, 0.79 for the indicator of evaluating and designing scientific investigations, and 0.78 for the indicator of interpreting data and evidence scientifically. All three values were in the high category, indicating an improvement in students' science literacy skills. These findings were reinforced by the results of the paired t-test, which showed a significance value of < 0.05, so it can be concluded that Etno-STEM-based science learning using Sidoarjo's typical foods had a significant effect on students' science literacy.*
Keywords : *Ethno-STEM; Sidoarjo food typical; Science literacy.*

INTRODUCTION

The 21st century is marked by rapid developments in science and technology, which require the education sector to prepare students to face competition in the era of the global economy (Pratiwi et al., 2019). In facing these challenges, education plays an important role in producing human resources capable of solving various problems in life. One of the efforts that can be taken to improve the quality of human resources is through improving science literacy skills (Pratiwi et al., 2024).

Science literacy is defined as the ability to engage reflectively with issues and ideas related to science (OECD, 2023a). Science-literate individuals are willing to engage in reasoned discussions about science and technology, with key competencies including the ability to explain phenomena scientifically, evaluate and design scientific investigations, and interpret data and evidence scientifically (OECD, 2023a). According to (Fitri & Fatisa, 2019), science literacy is an understanding of scientific concepts and processes that enables individuals to use their knowledge in decision-making and contribute to economic progress, national development, and cultural preservation.

Science literacy is important for students to have in carrying out learning activities, especially in Natural Sciences (Amala et al., 2023). Science literacy is important in science education because it supports the development of scientific knowledge, skills, and attitudes that students need to face the challenges of the 21st century.

In this context, science literacy has several dimensions of usefulness, namely: 1) Equipping students with basic scientific skills such as explaining phenomena scientifically; 2) Fostering critical, logical, and creative thinking skills; 3) Encouraging students to be active in making appropriate and wise decisions related to issues involving science and technology in real life, whether in the context of the environment, health, or society; 4) Increasing the relevance of science learning to everyday life, because science literacy emphasizes the application of scientific concepts in solving real problems faced by students; 5) Adapting learning to the demands of the 21st century, which is leading to a paradigm shift from teacher-centered to student-centered learning; and 6) Laying the foundation for the formation of scientifically literate citizens who are able to participate actively and responsibly in an increasingly complex and technology-based society (Pertiwi et al., 2018).

Through science literacy, students are able to utilize scientific advances to make informed decisions and accept alternative perspectives based on scientific evidence. Therefore, science literacy contributes significantly to improving individual well-being while promoting broader social and economic progress in society(Amala et al., 2023).

However, in reality, the achievement of science literacy among students in Indonesia is still not encouraging. This is reinforced by the results of the 2022 Programme for International Student Assessment (PISA) assessment, which shows that the average science literacy score of Indonesian students is only 383 points. This score is far below the average of the Organisation for Economic Co-operation and Development (OECD) member countries, which is 485 points, and is still below the international average (OECD, 2023b). This condition is in line with several studies conducted by researchers in Indonesia on the profile of science literacy skills, including by (Pratiwi et al., 2024) as well as (Tillah & Subekti, 2024), which shows that the science literacy skills of junior high school students in his area are in the low category.

Low science literacy achievement among Indonesian students is influenced by various factors. (Amalia et al., 2024) revealed that these factors include the curriculum and education system, the selection of learning methods and models, the availability of learning facilities, and access to learning resources and teaching materials. In addition, teacher-centered learning tends to make students passive during the learning process (Pertiwi et al., 2024).

Similar conditions were identified in one of the junior high schools in Sidoarjo Regency. Based on the results of observations, the learning process was still dominated by a teacher-centered approach, thereby limiting students' activity in constructing knowledge independently. This was reinforced by the results of preliminary tests conducted on eighth-grade students, which were measured using three indicators of science literacy skills, namely: 1) Explaining phenomena scientifically; 2) Evaluating and designing scientific investigations; and 3) Interpreting data and evidence scientifically. The average achievement was 18.9% for the first indicator, 45.6% for the second indicator, and 42.2% for the third indicator. Referring to the criteria for interpreting science literacy scores proposed by (Erniwati et al., 2020), these achievements are categorized as low for the second indicator and very low for the first and third indicators.

In order to address the issue of low science literacy among students, strategic efforts are needed in the implementation of learning that directly facilitates the development of science literacy skills. One approach that is considered effective in achieving this goal is the application of Science, Technology, Engineering, and Mathematics (STEM) integrated learning (Purbaningrum et al., 2024).

STEM is an interdisciplinary learning approach that combines four major scientific fields into a contextual and applicable whole. This approach is closely related to science literacy, as it requires an understanding and application of scientific concepts in solving real-world problems encountered in everyday life (Purbaningrum et al., 2024). Although STEM-based learning has been proven effective, (Banila et al., 2021), it has been noted that students' science literacy outcomes still vary, as students are not yet accustomed to an integrative approach. In line with this, (Sumaya et al., 2021) adds that one of the weaknesses of the STEM approach lies in students' lack of understanding of the concepts being studied. To overcome these limitations, the STEM approach has begun to be linked to local wisdom. This innovation is rooted in the idea of ethnoscience, which is the process of reconstructing indigenous science that has developed in local communities to be integrated into scientific science (Khoiri & Sunarno, 2018).

Ethno-STEM is culture-based STEM or local wisdom that makes greater use of local culture in the learning process (Ardianti et al., 2019). The purpose of the Ethno-STEM approach is to equip students with science and technology literacy through reading, writing, observing, and conducting scientific methods, so that students can develop and apply their competencies to solve everyday problems related to science (Idrus & Suma, 2022).

The Ethno-STEM approach in this research is contextualized through Sidoarjo's typical foods, which have cultural value and potential as sources of science learning. Local food products such as shrimp paste, shrimp crackers, and lontong kupang not only represent regional identity but also contain scientific aspects that are relevant for integration into learning, particularly in relation to the use of natural and artificial additives.

Through this context, students' science literacy can be improved because they not only learn to connect scientific concepts with real phenomena, but also develop critical thinking skills and make appropriate decisions based on scientific evidence. This kind of local wisdom-based approach is still relatively rare in science education, especially when it comes to linking regional foods with science literacy. Therefore, this research is expected to provide a new perspective in developing a more contextual and relevant science learning model for students. Based on this, the purpose of this research is to determine the effect of implementing Etno-STEM-based science learning on Sidoarjo's typical foods on the science literacy of junior high school students.

METHOD

This study is a quantitative experimental study using a pre-experimental method and a one-group pretest-posttest design, which can be described as follows:

Table 1. One Group Pretest-Posttest Design

O_1	X	O_2
Pre-test	Treatment	Post-test

Description:

O_1 : The value obtained before the treatment was applied (Pre-test)
O_2 : The value obtained after the treatment (Post-test)
X : Treatment (Ethno-STEM-Based Science Learning)

Based on the research design presented in Table 1, the research procedure was carried out in three main stages, namely pretest, treatment, and posttest. The first step was to give students a pretest to measure their initial science literacy skills before treatment. The second step was to administer the treatment through Ethno-STEM-based science learning on the subject of food additives using the project-based learning (PjBL) model, in which learning was carried out in four meetings. In this project, students produced products in the form of Sidoarjo typical foods, such as shrimp paste, shrimp crackers, and lontong kupang. The learning activities followed the six syntaxes of the PjBL model, namely: 1) Determining fundamental questions; 2) Designing project plans; 3) Preparing schedules; 4) Monitoring project progress; 5) Assessing results; and 6) Evaluating learning experiences. In the first meeting, steps 1-3 were carried out, while the second and third meetings focused on step 4, and the fourth meeting was directed at step 6. The third step was to administer a posttest to measure the final condition after the treatment was given.

The sample in this research consisted of one class of 20 students at a junior high school in Sidoarjo Regency. The sampling technique used was purposive sampling, which is a technique used when researchers set certain criteria or considerations in selecting samples.

The researcher's consideration in determining the experimental classes was based on the results of science literacy tests conducted in three classes, namely VIII-A, VIII-B, and VIII-C. Based on preliminary analysis, the average science literacy achievement of students in class VIII-A was the lowest compared to the other two classes, with a percentage of 20.3%, while class VIII-B achieved 27.3% and class VIII-C achieved 43.1%.

This condition indicates that class VIII-A has a greater need for intervention in terms of improving science literacy. Therefore, class VIII-A was selected as the experimental class to test the effectiveness of implementing Ethno-STEM-based science learning, so that it is expected to provide a clearer picture of the impact of this approach on improving students' science literacy skills.

The data collection technique in this research used a science literacy test consisting of 15 multiple-choice questions. The instrument was examined and validated by two experts, with an Aiken V index of 0.918, which is classified as very high, in accordance with the criteria (Retnowati, 2019) stating that a value above 0.8 indicates very high validity. In addition, the reliability of the instrument was tested using Cronbach's Alpha formula, and a value of 0.923 was obtained. A Cronbach's Alpha value above 0.6 is acceptable, and the closer it is to 1, the higher the internal consistency. Thus, the instrument in this research is declared valid and reliable.

In this instrument, researchers used a science literacy test based on science literacy indicators according to (OECD, 2023a), namely: 1) Explaining phenomena scientifically; 2) Evaluating and designing scientific investigations; and 3) Interpreting data and evidence scientifically.

Table 2. Science Literacy Question Guide

Science Literacy Indicators	Question Number	Number of Questions
Explaining Phenomena Scientifically	1, 4, 7, 10, 13	5
Evaluating and Designing Scientific Investigations	2, 5, 8, 11, 14	5
Interpreting Data and Evidence Scientifically	3, 6, 9, 12, 15	5
Amount		**15**

To determine the achievement of science literacy skills for each indicator, researchers calculated the percentage of achievement using the following equation:

$$NP = \frac{R}{SM} \times 100\%$$

Description:

NP : Science literacy score
R : Amount of questions answered correctly
SM : Maximum score of the test

The percentages obtained are then interpreted based on the following science literacy score criteria:

Table 3. Criteria for Interpreting Science Literacy Scores (Erniwati et al., 2020)

Criteria Interval	Criteria
86-100%	Very Good
72-85%	Good

58-71%	Fair
43-57%	Low
<43%	Very Low

The data analysis technique in this research used inferential statistics with the help of IBM SPSS Statistics 26 software. The analysis was conducted using a paired t-test with a significance level of 0.05 to determine the effect of Etno-STEM-based science learning on Sidoarjo's typical foods on students' science literacy. In addition, the researcher also used the N-Gain test to measure the effectiveness of learning. The N-Gain values obtained were then interpreted into three categories, namely high, medium, and low (Coletta & Steinert, 2020). The detailed N-Gain achievement categories can be seen in Table 4. To strengthen the analysis results, the percentage of achievement of science literacy indicators was also calculated to provide an overview of the improvement in students' science literacy skills before and after the implementation of learning.

Table 4. N-Gain Value Category

Category	N-Gain Value
High	N-Gain > 0,7
Medium	0,3 ≤ N-Gain ≤ 0,7
Low	N-Gain < 0,3

RESULT AND DISCUSSION

1. Result

This research was conducted at a junior high school in Sidoarjo Regency with the aim of determining the effect of Etno-STEM-based science learning on Sidoarjo's typical foods on students' science literacy. The results of the research show an increase in science literacy after the implementation of learning. This can be seen from the differences in the average pretest, posttest, and N-Gain calculations, which indicate the effectiveness of learning.

The average results of the three measurement stages, namely the pretest, posttest, and N-Gain, are presented in detail in Table 5 and visualized in the form of a graph in Figure 1 to clarify the increase in students' science literacy skills after the implementation of Etno-STEM-based science learning

Table 5. Average Science Literacy Scores of Students

Number	Science Literacy Indicators	Score		N-Gain	Category
		Pre-test	Post-test		
1.	Explaining Phenomena Scientifically	24	92	0,89	High
2.	Evaluating and Designing Scientific Investigations	22	84	0,79	High
3.	Interpreting Data and Evidence Scientifically	15	82	0,78	High

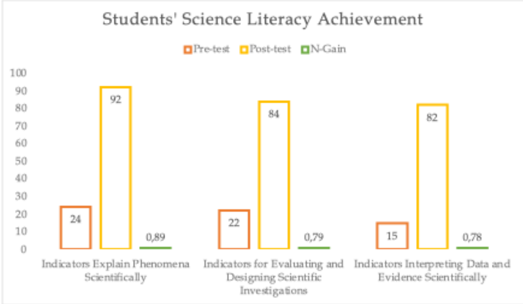

Figure 1. Student Science Literacy Achievement

Descriptive analysis using pre-test and post-test mean scores, as well as N-Gain calculations for each indicator, provided an initial overview of the improvement in students' science literacy. Next, inferential statistical analysis was used to test the significance of the improvement.

a. Normality and Homogeneity Test Results

Table 6. Normality and Homogeneity Test Results

Test	Sig.	Conclusion
Normality (Shapiro-Wilk)	0.164	Normally Distributed
Homogeneity (Levene Statistic)	0.393	Homogeneous

b. Paired Sample T-Test Results

Table 7. Paired Sample T-Test Results

Paired Samples Test				
	Mean	**t**	**df**	**Sig. (2-tailed)**
Pair 1 Pretest-Posttest	-65.660	-26.481	19	0.000

2. Discussion

This research was conducted by applying the Ethno-STEM approach, which contextualizes Sidoarjo's typical foods in science learning on the subject of food additives. The aim was to determine the effect of applying this approach on students' science literacy. The results showed that the Ethno-STEM approach had an effect on science literacy skills, as indicated by an increase in the average pretest and posttest scores and N-Gain calculations for each indicator.

In the first indicator, the achievement percentage increased from 24% (very low category) to 92% (very good category). This indicator assesses students' ability to explain phenomena scientifically, namely the ability to remember scientific concepts that are relevant to a particular situation and apply them to interpret and explain the phenomena that occur (OECD, 2019). The criteria for questions in this indicator require students to explain the cause-and-effect relationship of an event based on scientific concepts with stimuli in the form of texts or phenomena that are relevant to real life.

In this research, there are five questions that contain indicators explaining phenomena scientifically, namely numbers 1, 4, 7, 10, and 13. Questions 1, 7, and 13 measure students' ability to scientifically explain the function of natural and artificial additives (coloring, sweetener, preservative, flavoring) in Sidoarjo's typical food products. Meanwhile, questions 4 and 10 measure students' ability to scientifically explain the impact of using natural and artificial additives (coloring, sweetener, preservative, flavoring) in Sidoarjo's specialty food products. The N-Gain calculation for this indicator shows a value of 0.89, which is in the high category.

In the second indicator, the percentage increased from 22% (very low category) to 84% (good category). This indicator assesses students' ability to evaluate and design scientific investigations, namely that students can critically evaluate findings and investigations. This competency requires an understanding of the specific characteristics of scientific investigations, such as what needs to be measured, which variables need to be changed or set, and the steps that need to be taken to collect accurate and precise data (OECD, 2019). The question criteria for this indicator require students to identify variables in scientific investigations, such as independent variables, dependent variables, and control variables, as well as determine the experimental design that is appropriate for the objectives of the scientific investigation being conducted. The question stimulus is in the form of a description of procedures, experimental phenomena, or everyday problems that require investigation planning.

In this research, there are five questions that contain indicators for evaluating and designing scientific investigations, namely numbers 2, 5, 8, 11, and 14. Questions 2, 8, and 14 measure students' ability to evaluate the potential positive and negative impacts of using additives (coloring, sweeteners, preservatives, flavorings) in Sidoarjo typical food products. Meanwhile, questions 5 and 11 measure the ability to design simple scientific investigations to identify the effects of natural and artificial additives on the characteristics (shelf life, taste, and color) of Sidoarjo's specialty foods, taking into account experimental variables. The N-Gain calculation for this indicator shows a value of 0.79, which is in the high category.

Meanwhile, in the third indicator, the percentage increased from 15% (very low category) to 82% (good category). This indicator measures students' ability to interpret data and evidence scientifically, namely their ability to analyze and evaluate data, respond and argue to reach accurate conclusions (Winata, 2018). The question criteria in this indicator require students to interpret data and draw logical scientific conclusions based on empirical evidence. The stimulus used is in the form of a table of test results or a description of the results of a simple experiment related to real-life contexts.

In this research, there are five questions that contain indicators of interpreting data and evidence scientifically, namely numbers 3, 6, 9, 12, and 15. Questions 3, 6, and 15 measure the ability to interpret scientific data and evidence through graphs, tables, or qualitative descriptions of the effects of natural and artificial additives on the characteristics (shelf life, taste, and color) of typical Sidoarjo foods. Meanwhile, questions 9 and 12 measure the ability to analyze significant differences between the use of natural and artificial additives on the characteristics of Sidoarjo's specialty foods (durability, taste, and color). The N-Gain calculation for this indicator shows a value of 0.78, which is in the high category.

Based on three science literacy indicators, the indicator explaining phenomena scientifically achieved the highest average score compared to the other two indicators. These results show that students are able to remember and apply scientific concepts relevant to specific situations to interpret and explain phenomena that occur (OECD, 2019). However, these findings are in contrast to research (Pratiwi et al., 2024) which shows that indicators that explain phenomena scientifically do not dominate student achievement. This difference in results is likely influenced by the learning strategies and context of the material used.

Conversely, the lowest achievement was found in the indicator of interpreting data and evidence scientifically. This shows that students still have difficulty analyzing and evaluating data, responding and arguing to reach accurate conclusions. In this indicator, students are required to have the ability to interpret scientific evidence or data obtained through observation or based on existing theories or literature, so that it can be used to draw conclusions and provide logical reasons as to whether a statement can be accepted or rejected (Haerani et al., 2020).

These findings are in line with research (Tillah & Subekti, 2024) which also reports low achievement in the indicator of interpreting data and evidence scientifically. This indicates that these skills require repeated practice, familiarization with reading data, and more structured learning strategies, such as guiding students in interpreting tables, graphs, and simple experimental results. Although the average achievement on the indicator of interpreting data and evidence scientifically is lower than the other two indicators, the results of the study show that the achievement is still in the good category.

In the indicator of evaluating and designing scientific investigations, the average achievement of students was two percent higher than in the indicator of interpreting data and evidence scientifically. This indicates that students are already able to understand the basics of experimental design, although they still need guidance in developing more systematic and in-depth procedures.

Based on the analysis results, the increase in achievement is not only shown through the difference between the pretest and posttest scores, but is also reinforced by the N-Gain calculation, which provides a more in-depth picture of the categories of improvement. The N-Gain values for the three science literacy indicators are 0.89, 0.79, and 0.78, respectively, all of which fall into the high category. These findings indicate that the application of Etno-STEM-based science learning using Sidoarjo's specialty foods has proven effective in improving students' science literacy.

After conducting an improvement analysis using the average science literacy achievement, the next step is to perform inferential statistical analysis to test the significance of the improvement. The data obtained were analyzed using a paired t-test with a significance level of 0.05. Before the analysis was conducted, the researcher first tested the prerequisites in the form of normality and homogeneity tests. The normality test in this study was conducted using Shapiro-Wilk, which was chosen because the sample size of the study was less than 50 students.

Based on the normality test presented in Table 6, a significance value of 0.164 was obtained. This value is greater than 0.05, so the data is declared to be normally distributed. Furthermore, the results of the homogeneity test showed a significance value of 0.393, which is also greater than 0.05. These results indicate that the data variance is homogeneous.

After fulfilling the assumptions of normality and homogeneity, the analysis was continued using a paired t-test. The paired t-test was conducted to determine whether there was an effect of Sidoarjo-based Etno-STEM science learning on students' science literacy. The hypothesis in this study was accepted if there was a significant difference between the pretest and posttest results, with the following formulation $H_0: u_1 = u_2$(there was no difference between the pretest and posttest results) dan $H_1: u_1 \neq u_2$ (there is a difference between the pretest and posttest results). The decision-making criteria are based on the significance value (p-value). If the significance value is greater than 0.05, then H_0 is accepted and H_1 is rejected. Conversely, if the significance value is less than 0.05, then H_0 is rejected and H_1 is accepted.

Based on the t-test results in Table 7, a significance value (Sig. (2-tailed)) of 0.000 was obtained, which is smaller than 0.05. Thus, H_0 is rejected and H_1 is accepted. Therefore, these findings indicate that Etno-STEM-based science learning using Sidoarjo's typical foods has an effect on students' science literacy. This is in line with research conducted by (Wulandari & Hanim, 2023), which states that the Ethno-STEM approach has the potential to help teachers improve students' science literacy in science learning. This approach is also considered capable of creating meaningful learning experiences, so that the knowledge and skills acquired are easier to remember and can be applied in facing the challenges of the 21st century. In line with these findings (Nofiana & Julianto, 2018), it shows that local wisdom-based learning can improve students' science literacy skills. Before local wisdom-based learning was implemented, students' science literacy skills were categorized as very low. After local wisdom-based learning was implemented, they were categorized as good.

In this research, Ethno-STEM was realized through activities involving the production of Sidoarjo specialty foods by students. The aspect of ethnoscience is reflected in the traditional knowledge of communities that have long applied scientific principles even though they are not familiar with modern theories. For example, in making Sidoarjo shrimp crackers, the community in the past used garlic and salt as natural additives to preserve food ingredients. This method was based on generations of experience that had proven effective in maintaining food quality.

However, with the development of science and technology, this practice has shifted with the emergence of artificial additives such as formaldehyde or borax, which, although capable of providing longer shelf life, can have negative health effects. The comparison between traditional and modern practices became the starting point for students to understand the relationship between the community's indigenous science and the concepts of science learned in school.

The integration of STEM in this learning process is evident in the various stages undertaken by students. The science aspect is obtained when students collect data on the types of natural and artificial additives that will be used in the manufacture of food products. From the results of this data collection, students then analyze the function of additives scientifically, while reflecting on the local wisdom value of their use.

The technology aspect is present through the use of graphic design applications that students use to create designs for the appearance of the distinctive food products to be produced. Through this activity, students learn to integrate digital skills with visual creativity so that the resulting products not only reflect scientific concepts but also have aesthetic value that supports visual appeal and commercial value.

The engineering aspect is evident in the students' ability to systematically outline the steps involved in producing the selected Sidoarjo specialty food. Students are guided to choose appropriate ingredients, determine the sequence of work, and ensure the correct processing techniques so that the resulting product matches the design that has been created.

The mathematics aspect is reflected in the data reporting and analysis activities carried out by students. At this stage, students measure the amount of additives used in the manufacture of products, then observe the characteristics of the product results, including color, taste, and durability. The data obtained is then processed into tables and graphs so that it can be analyzed more systematically to support scientific conclusions.

This series of Etno-STEM-based activities directly supports the development of students' science literacy. Through the experience of connecting everyday phenomena with science concepts, students are trained to explain phenomena scientifically, for example, explaining the difference between the functions of natural and artificial additives in the food preservation process. When conducting simple experiments and designing products, students are trained to evaluate and design scientific investigations, such as comparing the durability of products preserved with different additives. In addition, when processing data such as compiling tables and creating graphs, students develop the ability to interpret data and evidence scientifically. Thus, Etno-STEM-based science learning through Sidoarjo's typical foods not only provides a contextual and meaningful learning experience, but also strengthens the three main aspects of science literacy, namely explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically.

CONCLUSION

This research shows that students' science literacy increased after the implementation of Etno-STEM-based science learning through the context of Sidoarjo's typical foods. The increase in science literacy was based on the results of a paired t-test, which obtained a significance value of 0.000. The significance value obtained was less than the significance level of 0.05, so H_0 was rejected and H_1 was accepted. Thus, it can be concluded that there is an effect of Etno-STEM-based science learning using Sidoarjo's typical foods on students' science literacy. In addition, the effectiveness of the learning application was demonstrated through the N-Gain values for each science literacy indicator, with results that were consistently in the high category.

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