

MULTIMODAL REPRESENTATIONS STRATEGIES IN TEACHING SCIENCE TOWARDS ENHANCING SCIENTIFIC INQUIRY SKILLS AMONG GRADE 4

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ABSTRACT

One of the main concerns of learning science is for the pupils to fully understand the natural world and infer ideas based on the evidences attained from their work. Science as a subject matter in the early years of learning needs to be fully understood for the pupils to be ready for a higher level of education. Science as a general education component in the curriculum and, as perceived by the students as a challenging subject, should have science educators who create learning strategies that are relevant and engaging to enhance the scientific inquiry skills of the pupils. This study introduced the multimodal representations strategies in teaching science to improve scientific inquiry skills among Grade Four pupils. Using two groups of pre-test and post-test experimental research design led to achieving the study objectives participated by 75 Grade Four pupils at San Joaquin Elementary School of the Academic Year 2020-2021. The result showed that using the multimodal representations strategies in teaching science helped students improve their scientific inquiry skills. Likewise, results revealed a significant improvement in the respondents' level of performance from the beginning level (observing patterns, determining relationships, drawing conclusions, and communicating ideas) to a proficient-exemplar level of performance. Furthermore, the study suggests that multimodal representation strategies resulted in a significant increase in students' scientific inquiry skills, promoting high engagement in learning.

Keywords: Multimodal Representation, Scientific Inquiry Skills, Engagement, T-test, Philippines

INTRODUCTION

Science as a subject matter is not about learning the concepts and facts; it is how a person's way of thinking and developing skills to fully grasp and understand the phenomena that occur naturally. For young learners to do this, they need to develop and practice the inquiry skills involved in science. Science inquiry skills are interlinked with young learners, as learning science content gives the form and activities for which it can be covered. Inquiry skills are fundamental to learning science content, and it allows students to apply, practice, and develop their scientific inquiry skills. With a greater emphasis on scientific inquiry skills, young learners can find out about the world around them through investigations (Wallace, &

Coffey, 2019). Introducing, developing, and applying scientific inquiry skills do not need to make science more complicated in an early learning context. Instead, these skills provide young learners and educators with a repeatable way of thinking and structuring their scientific explorations. As stated in the Philippine K-12 Science Curriculum Guide for Grades 4-6, every Filipino learner should have possessed and developed the essential skills of scientific inquiry which are: determining relationships, observing patterns, drawing conclusions based on evidence, and communicating ideas in a diverse way so that they can make fact-based meanings of the observations and/or changes that occur in the

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environment. Integrating multimodal representations into the science discipline could assist in bridging the difficulty in learning science because of a high cognitive skill required to understand the subject content and applying its knowledge to answer questions in every situation. In addition, having knowledge about the impact of digital tools and printed materials on the educative process is required as they can change on how the way knowledge is represented and re-represented. Its importance in teaching and learning science as this discipline means ideas in multimodal forms such as linguistics, experimental, symbolic, and kinesthetic. Tytler et al. (2020) argue that multimodal representations in science education are essential to empowering students in scientific activity.

This paper reports the emerging themes from an experimental study documenting how effective the used multi-modality is in the primary science discipline as well as examined how students learn science with a multimodal representation strategy. A socio-constructivist perspective of science education is applied in the research and contributed to a multimodal conceptual framework. Enhancing scientific inquiry skills was viewed through this multimodal lens, and the aim was to document how teachers and students used the multimodal representations to represent key science concepts. This study is conducted with the 75 pupils from San Joaquin Elementary School. The research activity occurred in conjunction with the teachers' new teaching modality during this time of pandemic under modular distance learning. The data that will contribute to the studies will include the researcher's self-made pre-post-test, digitalized learning materials, printed materials, and lesson exemplar.

OBJECTIVES OF THE STUDY

The study was conducted to 1) determine the impact of print-based and digital-based multimodal representations in enhancing the scientific inquiry skills of pupils, and 2) identify if significant differences exist among the mean post-test scores of the two groups in their scientific inquiry skills.

METHODOLOGY

This study covered Grade 4 pupils of San Joaquin Elementary School, San Francisco District, San Pablo City, Laguna Philippines, of Academic Year 2020-2021. A pretest-posttest experimental research design was used to investigate the relationship between pupils' scientific inquiry skills connected to multimodal representations strategies (printed and digital). The respondents came from the two sections of San Joaquin Elementary Schools, with 38 Grade Four respondents in the first section exposed to print-based multimodal representations and in the other section with 37 pupils exposed to digital-based representations with a total of 75 respondents.

The data gathered in this study showed how well the pupils performed in the class and how multimodality strategies affect their scientific inquiry skills. The researcher also used a self-monitoring tool to monitor the learners and facilitate their learning activities at home through text messages, calls, Facebook chats, etc., during this time of modular distance learning.

Hence, the researcher also constructed a self-made pre-test and posttest to measure the Grade 4 pupils' learning outcome through different teaching strategies aligned with the teaching competencies. A designed pre-test and posttest in various teaching strategies consisted of 40-items under the topics in Quarter 2 Earth and Living Things in Science 4. The experts carefully validated the teacher-made instrument in Science from San Francisco District. One principal and four master teachers have a specialty in Science IV, as well as the digitalized materials like Power point presentation, video lessons, e-posters, printed materials, and a lesson exemplar used in the study.

The researcher carefully identified the target respondents of the study. The researcher also explained to the parents and guardians of the respondents what learning resources their children will receive. The researcher also drafted a letter to the respondents' parents asking permission for them to their children to be exposed to two types of multimodal representation strategies during this study. Print-based Multimodal Representation



included presenting ideas and concepts of science through printed materials examples were visual cues like images, graphs or charts and lecture notes, books, modules, graphic novels, comics, and posters. In contrast, Digital-based Multimodal Representation included presenting ideas and concepts of science through film, animation, digital slides presentations (e.g., PowerPoint), e-posters, digital stories, and video lessons. Learning resources were provided from the Division Office of San Pablo City (through recorded video lessons from the DepEd T.V.). The researcher assured the parents that the learning materials will be given to each group after the study.

A pre-test using the researcher-made test anchored with the most essential competencies provided by the Department of Education (DepEd)

and in line to enhance the scientific inquiry skills of the pupils, which are observing patterns, determining a relationship, drawing conclusion, and communicating ideas, was administered to the group exposed with printed-based representation and the other group exposed to digital-based representation before the experimentation or intervention. Groups were taught with the same content outline following the most essential competency (MELC) and Budget of Work (BOW) of DepEd Philippines. The researcher administered the study within eight weeks or a total of 40 days. Finally, a researcher-made post-test was used to measure the academic achievement of the respondents.

RESULTS AND DISCUSSION

1. Pre-test and Post-test Scores Performance of the Pupils under Print Based

Table 1 shows the pre-test scores of respondents in terms of inquiry skills, observing patterns, determining relationships, drawing

conclusions, and communicating ideas of pupils who were exposed to print-based representations

Table 1
Pretest Scores Performance of Respondents under Print Based Representations

	Observing Patterns		Determining Relationships		Drawing Conclusions		Communicating Ideas	
	f	%	f	%	f	%	f	%
<i>Exemplar</i>	0	0	0	0	0	0	0	0
<i>Proficient</i>	9	23.7	8	21.1	8	21.1	15	39.5
<i>Developing</i>	11	28.9	27	71.1	22	57.9	14	36.8
<i>Beginning</i>	18	47.4	3	7.9	8	21.1	9	23.7

Students under observing patterns were expected to perform on how to utilize their natural interest and experiential skills, promoting deeper understanding and engagement with every task assigned to them. Based on the pre-test result, 47.4 percent of the pupils were at the beginning performance level. In determining the relationships, it was the basis of the pupils' performance if they can interpret relationships between variables; know how to interpret graphs or

data by looking for patterns and trends. The result of the pre-test scores showed that most of the respondents fell under the developing performance level before the intervention. Likewise, in drawing conclusions, 57.9 percent of the respondents in this group were at the developing level. It was observed that most of them have not yet developed these skills where they were expected to imply or infer the information and be able to tell and state the information clearly.



Lastly, in communicating ideas, the respondents were expected to perform or process using words in expressing their ideas, making sounds and signs, or behaviors to express or exchange information or express their thoughts where they manifested proficient performance levels before the implementation of print-based multimodal representations.

The results suggest that there was a low-performance mastery in scientific inquiry skills. Gordon (2006) in his visual media, using printed materials has advantages for every learner. It was extremely mobile, low cost, readily available, and easy to use. Students do not need special equipment to use it, and printed materials can be used anywhere at any time. Students can study the materials at their own convenient time.

Table 2
Post-test Scores Performance of Respondents under Print Based Representations

	Observing Patterns		Determining Relationships		Drawing Conclusions		Communicating Ideas	
	f	%	f	%	f	%	f	%
<i>Exemplar</i>	12	31.6	7	18.4	1	2.6	13	34.2
<i>Proficient</i>	5	13.2	13	34.2	16	42.1	16	42.1
<i>Developing</i>	21	55.3	18	47.4	21	55.3	9	23.7
<i>Beginning</i>	0	0	0	0	0	0	0	0

Table 2 presents the posttest scores of the respondents after they were exposed to print-based multimodal representations. The posttest scores show that the print-based group led to developing mastery level under observing patterns (55.3%). After using print-based multimodal representation strategies, an improved level was seen from the beginning to developing performance levels. Likewise, determining relationships shows significant improvement (47.4%) from developing level to proficient level, and there was also the emergence of exemplar performance level. On the other hand, drawing conclusions (55.3%) showed that most of them were at the proficient performance level after the intervention. Lastly, communicating ideas showed a proficient mastery level among the pupils, with 42.1 percent of the total respondents.

clearly with the help of pictures, graphs, and charts. As stated by (Gilbert J.K. 2010) that visual representations as a tool can support cognitive understanding in science that have been found out and studied effective. Many studies in science education have explored and applied the use of images in science textbooks (Dimopoulos et al. 2003; Bungum 2008), which also had a more significant impact on learning and acquiring knowledge. This was same with the statement that the human eyes are quickly drawn to colors and patterns. Person can easily identify differences between colors, as well as in shapes from square to a circle. Students also developed their aural skills by performing tasks that involve creating sounds and their kinesthetic features through engaging real-life situation performance tasks that are given to them through printed materials.

The results also present data improvement on the pupils' performance level after the exposure due to the emergence of exemplar levels among the respondents. Again, communicating ideas showed the most progress, with a 34.2 percent exemplar level among the respondents. Based on their outputs and activity sheets, the respondents in this group can explain the ideas and concepts

Lastly, their linguistic side was developed through reading a poem, short text, paragraphs, and stories related to the lessons. Even though there are emerging new ways and technologically enhanced materials, teachers should not forget that printed materials still benefit students' learning. The findings suggest that the significant strength in using printed materials is linked to the students' participation in learning. It is seen in the



students' learning outputs and performance that print-based representation helps in improving their scientific inquiry skills.

2. Pre-test and Post-test Scores Performance of the Pupils under Digital-Based

Table 3
Pre-test Scores Performance of Respondents under Digital-Based Representations

	Observing Patterns		Determining Relationships		Drawing Conclusions		Communicating Ideas	
	f	%	f	%	f	%	f	%
<i>Exemplar</i>	0	0	0	0	0	0	0	0
<i>Proficient</i>	14	37.8	22	59.5	10	27.0	19	51.4
<i>Developing</i>	10	27.0	12	32.4	23	62.2	7	18.9
<i>Beginning</i>	13	35.1	3	8.1	4	10.8	11	29.7

Table 3 shows the pre-test scores performance of the respondents before the implementation of the digital-based representations. The result shows that most pupils under observing patterns were at the beginning performance level (35.1%). Respondents were still developing their skills to utilize their natural curiosity and develop their observational skills, promoting deeper curiosity and engagement. Secondly, most of the pupils exhibited developing mastery in drawing conclusions (62,2%). It shows that they were in the middle level of performance before using digitized materials.

Furthermore, both determining relationships (59.5%) and communicating ideas (51.4%) showed proficiency among pupils. It showed that in these skills; the pupils achieve the exemplar level of performance. However, there is a need to develop these skills fully. The results suggest a low-performance mastery in scientific inquiry skills, for there was no emergence of exemplar level of performance in the four scientific inquiry skills. As stated by Rias and Zaman (2011), engaging the learners with digital learning materials and

technology to enhance their critical thinking skills, were the basis for developing scientific inquiry skills.

Utilizing the timely teaching and learning techniques based on digital learning tools and technologies was very helpful. Singersulf (2006) stated that using digitalized learning tools/materials and enhanced technology enables learners to develop effective self-directed learning skills. They can easily identify what they need to know and learn, as well as find solutions to the problems, and the use of digital resources, apply the information or solutions on the problem at hand, and even analyzed resultant feedback which is related to enhancing the scientific inquiry skills in science. Thus, it will increase their efficiency and productivity. Learners will also develop positive feelings of accomplishment from mastering new knowledge and skills using digitalized learning. This gave them the sense of confidence when they needed to understand even more in learning new things and eventually develop their scientific inquiry skills.



Table 4
Post-test Scores Performance of Respondents under Digital-Based Representations

	Observing Patterns		Determining Relationships		Drawing Conclusions		Communicating Ideas	
	f	%	f	%	f	%	f	%
<i>Exemplar</i>	18	48.6	15	40.5	5	13.5	16	43.2
<i>Proficient</i>	19	51.4	19	51.4	32	86.5	20	54.1
<i>Developing</i>	0	0	3	8.1	0	0	1	2.7
<i>Beginning</i>	0	0	0	0	0	0	0	0

Table 4 presents the post-test scores of the pupils in digital-based representations. It shows that 51.4 percent of the pupils were at the proficient level in terms of enhancing their observing skills. After being exposed to digitalized materials, they improved their natural curiosity and observational skills, promote deeper curiosity and engagement, support a more scientific approach to observation, and look beyond prominent features.

The results also revealed that in determining relationships, they manifested their performance through the learning tasks. For example, the students can interpret relationships between variables, interpreting graphs or data by looking for patterns and trends with the help of digitalized materials. Furthermore, the proficient performance level was manifested among pupils' drawing of conclusions, (86.5%) skills, and communicating ideas (54.1%). More than half of the pupils showed enhanced skills in scientific inquiry skills.

Post-test scores indicated that digital-based representation manifested good performance. In addition, post-test scores showed that students with the highest frequencies from the two groups had enhanced scientific inquiry skills. This result supports the findings of Nederhand et al. (2018)

3. The Test of Differences in the Pre-test and Post-test Scores of Respondents

Table 5 shows a significant difference in the pre-test and post-test scores performance of the respondents on scientific inquiry skills assessment exposed to print-based representations. The result

citing that the use of digital media provides a much more engaging student experience. Students can easily understand, comment, share, and, in the case of video, they can learn at their own pace by re watching it. Also, it allows the teachers to be more actively engaged with their students by using video lessons, as well as providing more personalized and engaging digitalized learning materials.

Learners using digitalized learning materials and technology became more engaged in the learning process and more motivated in developing their knowledge. In addition, they were actively learning, since they learned through engaging methods such as films, animation, digital slide presentations (e.g., PowerPoint), e-posters, digital stories, and video lessons. Since digital learning is far more interactive and memorable than immense textbooks or favorably lectures, it gives better context, a greater sense of viewpoint, and more interesting and engaging activities than traditional education methods (Sufliita, 2012) This allows students to fully connect with the learning materials. Another, this is to offer often a more exciting and involving way to grasps information.

group of respondents has increased mastery in scientific inquiry skills to observe patterns, determine relationships, draw conclusions, and communicate ideas.

Past studies have often found that students prefer printed learning material (Mizrachi, 2014). Also, the type of text is a significant factor to consider.



Table 5

Test of Differences in the Pre-test and Post-test Scores of Respondents under Print Based Representations

Pretest-Posttest	Paired Differences							
	Mean	SD	Std. Error Mean	95% CID		t	df	Sig. (2-tailed)
				Lower	Upper			
Observing Patterns	-2.632	1.667	.270	-3.180	-2.084	-9.730	37	.000
Determining Relationships	-1.237	1.125	.183	-1.607	-.867	-6.774	37	.000
Drawing Conclusions	-1.316	1.210	.196	-1.714	-.918	-6.701	37	.000
Communicating Ideas	-2.158	1.636	.265	-2.696	-1.620	-8.130	37	.000

According to Singer and Alexander (2017), the length or quantity of the text is among the various factors that greatly influence the choice of setup for reading the printed materials. Learners have been found to read a short text on the screen or in gadgets, but prefer a longer academic text in print (Mizrachi, 2014; Pálsdóttir and Einarsdóttir, 2016; Baron, Calixte, and Havewala, 2017;). It has been known that there are also indications that textbooks are used more to remember the concepts, ideas, searching for information, and in engaging to reading (Freeman and Saunders, 2015). To add in this claim, although it has been known that learners prefer the choice of having access to digitalized learning material, studies have found out that students are likely to print some of it out for their own reading. These claims and findings partly supported the study by Rockinson-Szapkiw, Courduff, Carter, and Bennett (2013), who reported highlighting the text, marking the pages, graphs,

charts, and colorful images seen as an advantage of the printed format. It will make the reader quickly grasp the information and retain to its memory.

Also, in using printed materials, students can learn at their own pace, or anytime that they want to read the printed materials. These findings can imply that learners consider the printed text to use as their medium for learning. The selection of the typestyles should not be undervalued because readability is an essential consideration in developing printed materials. A simple yet indeed significant reminder that graphics should be appropriate, and not to include pictures simply because they appear pleasing to the eye or colorful. Visual elements should be relevant to the lesson to draw students' attention to the topic and ultimately enhance learning. The placement of the graphics in the print materials should not impede understanding.

Table 6

Test of Differences in the Pre-test and Post-test Scores of Respondents under Digital-Based Representations

Pretest-Posttest	Paired Differences							
	Mean	SD	Std. Error Mean	95% CID		t	df	Sig. (2-tailed)
				Lower	Upper			
Observing Patterns	-4.000	2.915	.479	-4.972	-3.028	-8.345	36	.000
Determining Relationships	-1.676	1.684	.277	-2.237	-1.114	-6.052	36	.000
Drawing Conclusions	-2.000	1.374	.226	-2.458	-1.542	-8.852	36	.000
Communicating Ideas	-2.730	2.256	.371	-3.482	-1.977	-7.359	36	.000



The table above shows a significant difference between the students' pre-test and post-test scores' performance exposed to digital-based scientific inquiry skills assessment. Students improved their scientific inquiry skills and present ideas and concepts of science through film, animation, digital slide presentations (e.g., PowerPoint), e-posters, and digital stories. The finding is parallel to the statement by Sweller (2020). To understand the nature of the scientific inquiry, it is essential that students engage in a digitalized material. It makes them interested and can enhance learners' engagement in the learning process, as well as help teachers improve their lesson plans, and facilitate personalized learning. It

also helps the learners build the essential 21st century skills. Using digitalized materials to enhance the pupils' scientific inquiry skills has advantages, and some of those students find it easier to focus at their own time and pace. With digital materials available in learning, they won't have to worry about the information they need to learn. It is readily available at hand and with engaging and colorful materials like film, animation, digital slide presentations (e.g., PowerPoint), e-posters, digital stories, and video lessons. It will significantly affect the students' learning outcomes. On this note, the pupils become independent learners thus have improved scientific inquiry skills.

4. The Test of Differences on the Mean Post-test Scores of two groups

Table 7
Test of Differences on the Mean Post-test Scores of two groups

Print Based-Digital Based	t-test for Equality of Means						
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% CID	
						Lower	Upper
Observing Patterns	-3.889	73	.000	-1.969	.506	-2.978	-.960
Determining Relationships	-4.123	73	.000	-1.343	.326	-1.992	-.694
Drawing Conclusions	-5.009	73	.000	-1.329	.265	-1.857	-.800
Communicating Ideas	-2.109	73	.038	-.716	.340	-1.393	-.040

The table shows a significant difference among the post-test scores performance of the two groups of respondents on scientific inquiry skills assessment. The group exposed to digital-based representations got a higher mean score than the group exposed to print-based representations. Most of the respondents in this group tend to be more enthusiastic since they were using internet-based learning and engaging learning materials to understand the subject matter. It was observed through the videos sent by their parents through the

group chat while they were doing their performance tasks. The students were not bored since they were learning by presenting ideas and concepts of science through film, animation, digital slide presentations, e-posters, and digital stories. They critically used the images in finding the correct answer to the problem. The result of this research is related to Tang et al. (2014), stating that the frequent use of multiple representations to support science learning by giving an alternative means of representing a concept and ideas so that each

mode of representations supplement or make the interpretation (Ainsworth, 2021).

Digital learning provides far way better experience and context, a greater sense of view, and more interesting as well as engaging activities than the way we traditionally know it in the education processes. Learners can fully connect with the learning materials. Moreover, it offers a more engaging and involving way to digest and understand the informations. This is reflected in the retention rates and test scores of learners. Also, when learners are involved and can track their progress, it can improve their motivation and sense of accountability. During this time of pandemic and while the pupils are in the distance modular learning, parents and guardians can easily engage and use these learning activities to perk up their children's interest in education since digital materials make the process much more exciting, enjoyable, and engaging.

According to Holz (2019), parents and guardians can also explore online activities that will enhance their child's skills and knowledge, which can extend what they were learning in their classrooms, especially in this time of global pandemic. Digitalized learning materials and technology provide enjoyment for kids and many benefits in terms of developing a learner's well-being. Everyone can benefit from the digitalization of learning materials. Digital learning materials fill the gaps, especially in this time of pandemic where traditional classroom teaching and learning falls behind. Some of the efficiencies such materials bring are unmatched by conventional efficient learning techniques. The environmental impact it gives that the need for less paper for handouts and books to save the environment and with quick access to information and the ease of research, digital learning has provided an effective way to save, upgrade the resources, and increase both reach and impact to learners and educators alike. Also, digital learning materials and technology enabled educators and learners to share information with other educators and students in real-time efficiently. By embracing digital devices and linked learning, classrooms, virtual classrooms around the country and the globe can connect with

one another to share insights and increase knowledge, experience, and heighten communications skills.

Meanwhile, the group exposed to print-based representations also found it interesting to learn through the method. They were interested in learning through printed materials with the guidance of their parents. They have focus when they were using these materials to understand the concept. This was observed through videos and output of the pupils sent and submitted by their parents. Correspondingly (Kress, 2020), a multimodal text shows meaning through a combination of two or many modes. For example, a e-poster gives sense through various still images, written language, and spatial design. Each technique has its specific role and function in presenting the meaning. It usually gives a part of the message in a multimodal print; text and the images contribute to overall learning. Images may present or expand on the written texts or can be used to show different aspects of knowledge and ideas (Guijarro and Sanz, 2009). In this way, pupils also enhance their scientific inquiry skills through print-based representations.

CONCLUSIONS

The following conclusions are drawn:

1. The scores of the students in the pre-test and post-test are diverse—most of the students' pre-test scores fall under the beginning level of performance in scientific inquiry skills. Still, gradually increasing after manipulating different multimodal representations includes presenting ideas and concepts of science through printed materials using visual cues like images, graphs, charts, lectures notes, books, and modules.
2. Teachers' selection and utilization of print materials must be fitted on the learning needs of the students. Suitable print materials will appear attractive to students considering that graphics in print materials are static. The findings clearly show a significant

improvement in the student exposed to multimodal representations based on scientific inquiry skills assessment in observing patterns, determining relationships, drawing conclusions, and communicating ideas.

3. Among the two multimodal representation strategies, digital-based shows more improve score performances on the mean scores of the respondents on their scientific inquiry skills assessment. Multimodal proved to help understand Science IV concepts on Earth and Living Things.

RECOMMENDATION

Based on the finding and conclusion of the study, the following recommendations are presented:

1. The study may encourage the teachers to use different multimodal representation strategies in teaching and learning because it is not just the determination of the teacher that the pupil can grasp the lesson of the subject matter but also by presenting and exploring the concepts and ideas through the use of multimodal representation strategies such as print based representation.
2. The study may encourage the students to continue using and exploring the different multimodal representation strategies namely, presentation of ideas and concepts of science through film, animation, digital slide presentations (e.g., PowerPoint), and digital stories, so that they can easily absorb the concept and knowledge of the subject matter.
3. School administrators are encouraged to conduct or support the teachers in attending seminars and training on the timely and innovative teaching strategies same with multimodal representation strategies such

as print based representation and digital-based multimodal representation so teachers can apply to the teaching and learning process.

4. Future researchers may consider a more extended period of using the multimodal representation strategies in teaching and learning to improve their scientific inquiry skills. They may replicate this study using other tests that may be conducted to further assess the impact of multimodal representation strategies in teaching Science 4 on the enhancement of scientific inquiry skills.

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