

## Understanding multimodal representations of junior high school students when writing scientific explanations

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**Abstract.** This research is an attempt to analyze the understanding of the concept of static electricity in junior high school students expressed in the form of scientific explanatory text from the linguistic point of view, for the development of multimodal representation competence. Scientific explanations in the form of text made by 9<sup>th</sup>-grade junior high school students through worksheets in static electricity studies provided by experienced science teachers are data from this study. The text created by the learner is analyzed by examining lexicogrammar through a systemic framework analysis of Systemic Functional Linguistic (SFL). Our analysis identifies specific aspects of the language that students need to be appropriate in expressing an understanding of static electricity that is aligned with the scientific perspective and competence of multimodal representation of students from the teacher-created worksheet. The findings of this study indicate that conceptual understanding is not sufficient to develop multimodal representations competence. The implications of this research are expected to assist teachers in overcoming linguistic challenges in explaining static electricity and developing multimodal representations competence.

### 1. Introduction

There are four components of outcomes to prepare students in the face of the 21st century, the subjects and themes of the 21st century, learning and innovation skills, media and technology information skills, and life and career skills. Learning and innovation skills are components to prepare for the rapid complexity of life and the work environment in the future. These components include creativity and innovation, critical thinking and problem solving, communication, and collaboration [1]. The results of the survey of the Programme for International Student Assessment (PISA) in 2006 focusing its survey on science shows that Indonesian students' science literacy skills are still at a low level, 29% for content, 34% for process and 32% for context. A decade later in 2016 PISA reported that Indonesia was ranked 64th out of 72 participating countries with a score of 403 while an average score of 493. From these findings, especially in the context of science applications, it is evident that many students in Indonesia cannot link science knowledge he studied with the phenomena contained in everyday life. These data indicate that the objectives of science learning in Indonesia have not been satisfactory [2]. Ability to explain the natural phenomena both spoken and written is fundamental to science literacy. Scientific writing has a linguistic characteristic that interprets the reality of knowledge, values and the nature of science. By understanding the functions of these linguistic features, scientific literacy can be developed [3]. There are several previous studies related to the ability of students in communicating

the understanding of science learning outcomes. Using an integrated socio-constructivist and socio-semiotic framework and data analysis with lexicogrammatical (LG), We got identifiable challenges related to the language of students while explaining the phenomenon of the typical mass are still experiencing difficulties [4]. The analysis of inquiry reports by students results in several distinctive features of scientific writing, such as expansion clauses and lexical densities. Most reports contain only a few conclusions from the observations. Few students are able to produce linguistic patterns that express the use of scientific ideas and conclusions [5]. In the process of conceptualizing and communicating ideas and findings, scientists must use various methods to articulate their understanding. Professionally, scientists must use numbers, graphs, diagrams, mathematical equations, and even nonverbal cues when making scientific reports. All methods to represent these ideas and concepts differ in their representational modes. Students expressed their understanding using multimodal representation as well as scientists [6]. In this study in addition to analyzing the explanations made students after being given static electricity learning also described multimodal capabilities representation.

## 2. Method

This research uses a qualitative approach with case study method. The descriptive analysis focused on the scientific explanation-shaped explanatory phenomenon made by junior high school students in static electricity learning. Scientific explanations in the form of texts created by students are analyzed by examining lexicogrammar through a category analysis of the framework of Systemic Functional Linguistic (SFL). Participants in this study were all student class 9 semester I Year Lesson 2017-2018, in Junior High School State, West Java. All participants get science learning by a senior teacher who is experts in her field. One of the learning outcomes of science, in this case, the concept of static electricity is a scientific explanation text made students will be analyzed. The collection techniques used in this study are as follows:

- a. Explanatory text data is collected through worksheets in the assignment of learning.
- b. Interviews during the learning took place to explore more focused data and in (think aloud protocol).
- c. The classroom situation during the lesson is observed using the learning observation sheet.
- d. Post-learning data is taken through interviews both with students and teachers using interview guidelines.

Data obtained from worksheets of students in the form of scientific explanatory text. The collected texts are grouped according to identical arguments/themes from the text groups analyzed by the SFL ergative model. In the SFL view, each clause is based on three simultaneous meanings: experiential (as representational), textual (as a message) and interpersonal (in exchange). In this study, the focus of the researcher is on experiential (meaning experiential) clauses, that is about how students use language to represent 'what goes around them and within them' [7]. To analyze the meaning of the experience of a clause, the following linguistic classes are used:

1. Process: Usually expressed by verbs or verbal groups, and is associated with a small number of participants such as Medium, Agent, and Range.
2. Medium: Usually expressed by the noun or nominal group and indispensable participant without a process that will not 'exist'; both Process and Medium are the core clauses, which are the units of linguistic analysis.
3. Agent: It is also usually expressed by the noun or nominal group and is 'an entity that performs or acts; cause or instigator of the process'.
4. Range: Can be expressed with nouns or adverbs and refers to the 'boundary, extent, or nature of what the process'.
5. Circumstance: This is a prepositional phrase, the adverb group or the nominal group expressing the state (e.g., reason, condition, location, means, etc.) associated with the Process or Participant.

In this case study, multimodal representations are examined to aid our interpretation of language data. Here is an example of linguistic analysis on an experiential/experiential meaning clause.

**Table 1.** Experiential clause analysis

Clause	The Linguistic classes
plastic ruler	<i>Medium</i>
which is rubbed	<i>Process</i>
wool	<i>Agent</i>
pull out small pieces of paper	<i>Circumstance of condition</i>

For representative multimodal competence, it is measured by the multimodal representation rubric of the explanatory text created by students as in table 2 below. This rubric is focused on capturing the extent to which knowledge of student representations [8]. Therefore, the degree of difference is created to differentiate between students

**Table 2.** Multimodal representations rubric

Score	Representations
Goal	Description of Students in Using Multimodal Representation (Text, Table, Picture) to Express the Knowledge or Claim
0	Only text mode has no explanation
1	Only the text mode is a bit explanatory
2	More than one mode and there is little explanation
3	More than one mode and there is a complete explanation
4	More than one mode and there is a complete explanation and creativity

### 3. Result and Discussion

#### 3.1. Result

At the beginning of the lesson, Ms. Inna Khoerunnisa explores the early knowledge of student by demonstrating a static electricity phenomenon using a plastic ruler rubbed on woolen cloth and small pieces of paper. In groups, students work on static electricity phenomena using electric and magnetic kits, consisting of PVC rods, glass rods, hanging ropes, stative, wool fabrics and silk fabrics. All groups of students do what is instructed in the Student Worksheet. Students individually fill in experimental data in tables, answer questions and make inferences. The purpose of this lesson is to investigate the nature of the electrical charge. The research data during the classroom study was taken by recording 2 audio vidio, one record the situation during the learning and one more focus on one group only. In the focus groups researchers did think-aloud protocol, direct interviews with students during they work in the laboratory. Other data are learning documents created by teachers and reports of students' lab results. Other research data is the result of the post-learning interview both with the teacher and the student. This data is used as research triangulation. The scientific explanation of static electricity is the result of writing students after doing the activity of static electricity. Out of 31 students, only 25 articles were analyzed (one student did not finish writing his report). Each report contains an interaction picture of two objects with different types of electric charge. Ms. Inna asks the students to fill in the full learner's worksheets from the observation table, discussion in groups, answer questions, and make conclusions. Of the 25 scientific explanations of static electricity contained in the conclusions of this report is used as the focus of research analysis. There are two groups of explanations that can be categorized have similar conclusions.

During the group discussion, Ms. Inna asked the focus group to better guide students understanding the nature of the static electricity charge. Furthermore, she was guiding in practicum activities.

Teacher: "Last time ... by the time Mom demonstrated a plastic ruler with small pieces of paper, what happened to the paper?"

Imam: "Paper stuck!"

Teacher: "Why paper can stick with a ruler?"

Imam: "Because the ruler rubbed wool Mom ..."

Teacher: "After rubbing what happened to the ruler?"

Imam: "Ruler is hot Mom ..."

Teacher: "Well, is it because the heat of a piece of paper can stick to a ruler?"

Imam: Mmm ... "

Teacher: "Try Siti ... can help the Imam?"

Siti: "Yeah Bu ... maybe because there is electricity in the ruler Mom .."

Teacher: "Yes ... right! Where is the electric charge? "

Siti: "It's because of wool rubbed, Mom ... so there's an electric charge in a thread!"

Teacher: "Well now try to do what is instructed to worksheet to know the nature of the electrical charge"

From the above dialogue, it is found that Siti has the ability to solve the problem on what static electricity phenomenon demonstrates by the teacher. This becomes the initial capital to further understand the nature of the electrical charge that must be obtained through practicum activities. From the result of the conclusion of the practicum written by the learner there are several clauses to be analyzed that are general they write the statement as follows:

1. The two glass rods polished with silk, repelling each other.
  2. Both PVC poles are rubbed woolen fabric, rejecting each other.
  3. Glass-polished silk rods and PVC poles are wool rubbed, pulling each other pull.
  4. If a similar object refuses, whereas if not a kind of pull. This is because the electric charge is static.
- Data for multimodal representations competence for each representation indicator is obtained as follows:

**Table 3.** The multimodal ability of representations scores of students

Representations	Score	The number of students
Description of Students in Using Multimodal Representation (Text, Table, Picture) to Express the Knowledge or Claim	0	5
	1	15
	2	3
	3	2
	4	-

### 3.2. Discussion

With regard to the multimodal capabilities of representation, the scans appear in the table 100% of students have capabilities in text mode. The number of students who have more than two representation modes is about 20%. It shows less than half of students have not been able to use at least 2 representational modes although only 8% can provide a complete explanation. The understanding of junior high school students about the concept of static electricity represented in the form of text (scientific explanation) is analyzed using SFL, the authors use the low-inference coding category [4] that is to make an explanatory classification, whether the nature of the static electricity charge is described in macroscopic and/or submicroscopic. Macro and submicro references are found in the scientific explanations of each learner which provides a useful organizational framework for further analysis. Then the author uses five categories of SFL ergative models namely, Process, Medium, Range, Agent and Circumstance to classify the LG Resource used by students in

their scientific explanatory text. Explanation text analysis is done clause per clause. Classification is based on the meaning of each clause derived from the LG's ability students in making scientific explanatory texts. The table below illustrates how three examples of clauses are found in the learner.

**Table 4.** The clause of the nature of static electricity analysis

Explanations	Content Analysis	LG Analysis
The two glass rods polished with silk, repelling each other	Macroscopic	Medium: The two glass rods
The scrubbed ruler will pull the piece of paper	Macroscopic	Range: The piece of paper
Transfer of negative electric charge from wool to plastic bar	Submicroscopic	Range: Negative electric charge

Based on the content analysis there are two types of scientific explanatory texts created by students, namely:

- a. Macro reference: explains the nature of the static electric charge in terms of empirical, macroscopic entity nature (macro-level representation).
- b. Sub submicro reference: explains the nature of the electrical charge in terms of negative and positive electrical charges (micro-level representation).

The results of both macro reference and submicro references found that students have difficulty in differentiating and connecting macro references and submicro references. As an example of a transcript of the teacher's dialogue and students, it is revealed that the plastic ruler can pull the pieces of paper as it is woolly rubbed and heat, whereas the expected answer is the displacement of negative static electricity from the wool to the plastic ruler. Heat is simply a result of rubbing wool on a plastic that essentially gives energy to move (excitation) electrons from wool to a plastic ruler. LG's ability of students in making explanations of the nature of static electricity charges at the macro-level can be grouped as follows:

- a. Both of glasses poles rubbed silk when brought near will refuse.
- b. PVC poles woolen cloth when brought closer will refuse.
- c. Glass rods are polished silk with PVC poles wool rubbed when brought closer will pull. In making this macro-level explanation, Circumstance of the condition is widely used, with the word '*approach*', '*push*', '*dodge*', '*stay away*', '*follow*' and '*stick*' as '*refuse*' or '*pull*'. The widely used Circumstance of condition Medium, *glass rods*, and *PVC rods*.

Whereas when students make explicit submicro level can be grouped in:

- a. Electron.
- b. Proton.

In explanation submicro level is a lot of use Circumstance of the condition, similar electrical charges will refuse and different types of electric charges will pull. At both levels, both the macro reference and the submicro reference have different meanings. Students are not familiar with electrons or protons and have not known the transfer of electrons from one object to another. From the observation, they suspect if two objects the same when brought closer will reject the opposite when two objects of different types will pull each other interesting to arrive at the understanding that the refuse or pull is essentially a static electricity charge.

#### 4. Conclusion

Based on the results of the analysis of the text of scientific explanation students show that at least some of the difficulties that students have in communicating their learning, especially in making reports of activities that are a representative laboratory. Many students face challenges/conceptual difficulties because of ambiguity. This is also supported by the weak multimodal data of

representation of students in analyzing and drawing conclusions from the activity of the nature of static electricity.

From a language perspective, this study shows that the challenges of students are not only limited to the conceptual learning of the nature of static electricity charges but include the demands of representation contained in the use of the language. So for the teachers to prepare the curriculum and have skills in addition to the concepts of learning but the use of language skills of students must be considered.

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