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**Article**

# Science Learning Discourse based on Classroom Representation Practice to Process Concept of Material Pressure

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**ABSTRACT**

Science learning should involve the use of active representation as a medium of communication between teachers and students. This is because representation becomes a medium of communication in the processing of science concepts provided by teachers, and the abilities produced by students themselves during science learning. This study aims to explain class discourse in science learning at SMPN 1 Jetis, based on the focus of discussing the relationship between knowledge representation, and communication patterns. The instruments in this study are questionnaires, and representation ability tests. The data obtained is tabulated in Microsoft Excel, then it is analyzed descriptively. The results showed that science learning at SMPN 1 Jetis was mediated with three types of existing representations, namely active, iconic, and symbolic alternately and simultaneously. The representation ability of students of SMPN 1 Jetis during the learning of the concept of material pressure, reached a score of 81.25 in the category of excellent representation ability; and 2) the shift of the three patterns of combination of representations that exist in science learning at SMPN 1 Jetis directs learning to dialogical, and authoritative communication patterns.



## INTRODUCTION

The strong cognitive tradition in science education has led to scientific concepts as products of science and representations as processes to be viewed separately from each other. Representation is a way of modeling, a way of acting, and directing a class discussion to a certain type of communication. Representation becomes a sign because it explains something of an idea or key explanation about an object or reference to someone (pupil). According to Brunner, the grouping of types of representations that exist in science classes is based on the pupil's mode of thinking, which divides the types of representations into 3: firstly action-based active representations are concrete stages involving direct/real learning modes, secondly iconic image-based representations involving images resembling concrete situations, and thirdly symbolic representations involving abstract words and symbols (Tang, 2016).

The application of the 2013 Curriculum in the implementation of learning requires students to be able to process their knowledge more actively. The implementation of learning is also required to be able to develop the competence of attitudes, skills, and knowledge possessed by students (Nurachman & Irawan, 2020). Teachers who play a central role in the implementation of learning are also required to have paedagogical abilities in designing learning methods and models that can increase the capacity of students' abilities. The lack of various learning models that teachers apply during the learning process will be one of the factors that make students tend to be less active, and less motivated in the learning activities carried out (Arianto & Fauziyah, 2020). According to Kurnianto & Dwijanant, In 2010 science subjects also strive to educate students not only to have an understanding of their knowledge but also to have good skills according to the purpose of learning, be able to train in carrying out research that is adapted to science, be able to have a disciplined attitude, be responsible, honest or as is, and able to cooperate in a community or group, and able to implement his knowledge in daily life around him (Hamidah & Mubarak, 2020).

The use of representation in science classes occurs both instructively from the teacher and arises and is generated by the pupils themselves. Research by Hubber & Haslam, 2010 shows that a focus on student-generated representation makes significant results on conceptual understanding of science (Prain & Tytler, 2012). Prain & Tytler explained that the construction of representation can support science learning in terms of 3 points of view used, namely the semiotic dimension of representation as a symbolic tool of meaning in science, the epistemic dimension of the use of various material and symbolic practices of the process of carrying out and reporting on science investigations, and the dimesion of epistemology with the process of reasoning in science for students as individuals and classroom communities and can be improved by building and interpret their own representations. Any attempt to explain concepts in science makes it clear that the various representational practices used in science classes become an inseparable urgency with existing class communication patterns to achieve science learning goals to make predictions by way of abstract modeling of scientific theory in building a new knowledge in science. This is closely related to the processing of existing theories along with the authentic experiences that the pupil has done, so that the pupil processes and relates the various experiences he has already possessed to a knowledge that can be communicated correctly, as Latour argues that interpreting science involves understanding the process by which data is transformed into theory through a series of representative trajectories (Prain & Tytler, 2012).

Departing from this background, it can be concluded that studying science means connecting the reality of nature with the scientific point of view that is communicated. So this research draws to focus on how the representation patterns used affect the knowledge communication that occurs during science learning at SMPN 1 Jetis.

## METHODS

This research was conducted from January to May 2021. Data collection was carried out at SMPN 1 Jetis which passed on Jl. Jenderal Soedirman 28A Josari, Jetis District, Ponorogo Regency. Data collection was carried out by means of observation, documentation and interviews to 64 samples of students in class 8G and 8H of SMPN 1 Jetis. The observations were made using mortimer & scott's analytical framework which was based on observations related to aspects of focus analysis, approaches, and learning actions as classroom discourse.

**Table 1**. Mortimer Analysis Techniques & Scott (2003)

| Analytical Aspects | |
|---|---|
| **i. Focus** | 1. Teaching purpose |
| | 2. Content (Tekanan Zat) |
| **ii. Approach** | 3. Communicative approach |
| **iii. Action** | 4. Teacher intervention |
| | 5. Interaction pattern |

Furthermore, the entire data obtained through observation, documentation, and interviews were analyzed to construct phenomena and find hypotheses to find relationships between categories of research focus variables, so that the analysis technique used was the analysis of the Cresswell model. This analysis begins with the first step, namely organizing and preparing data for analysis (organizing and preparing data that will be analyzed). The raw data to be analyzed is organized by data collection date, data source, data type, data description, data nature. The data sources here are science teachers of SMPN 1 Jetis, students, and observers. Types of data in the form of observation results (learning activities), interview results, documentation; the nature of confidential and non-confidential data; a data description is a brief description of each collected data.

The next stage is to read or look all the data. Researchers must read all the collected data, in order to know what has been obtained, the source of the data and its meaning. Researchers should know each informant produced any data, and compare it to each other. The researcher further reduces which data is important, new, uniquely related to the research question. Furthermore, the researcher sorts / classifies / categorizes / groups / creates themes for the data that has been selected.

The third stage is the start coding all the data (coding the entire data). Coding is the process of marking data that has been grouped. This study discusses the theme of the types of representation consisting of active, iconic, and symbolic representations and their relationship with the communication of formed class knowledge, and is grouped into dialogical and authoritarian communication. This stage is carried out to categorize data related to these themes.

The fourth stage uses coding process to generate a description (using coding as material to create a description). Through coding, researchers produce categorization of research data which is a finding. Furthermore, the researcher makes a brief and systematic description so that the themes become clear. The description starts from the explanation that the theme is a new finding, starting from the general to the specific.

The fifth stage is interrelating themes. At this stage, the researcher looks for the relationships between the themes that have been acquired. From this study, data related to the representation used by teachers are connected with the pattern of classroom communication that is formed, whether there is a relationship with each other.

The final stage is interpreting the meaning of theme giving interpretation and meaning about the theme). The results of constructing the relationship between themes need to be given interpretation so that others understand them. In this case, the data provided by interpretation is related to the analysis of the combination of representations with classroom knowledge communication generated during science learning (Sugiyono, 2018).

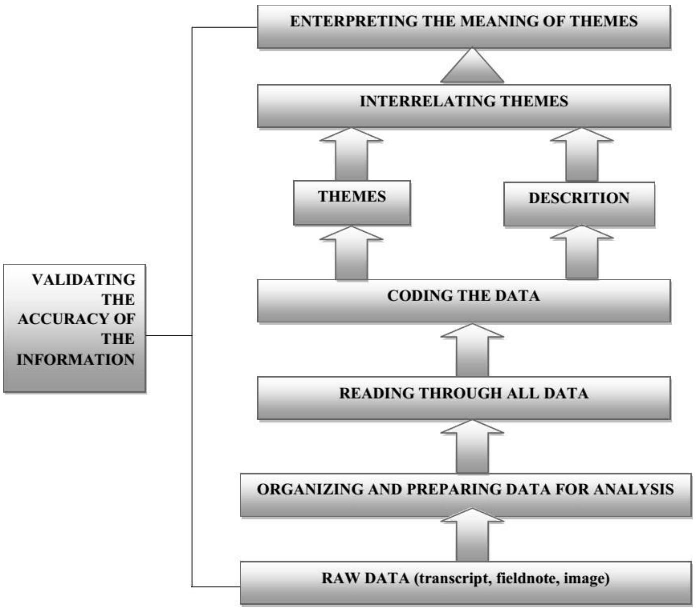


**Figure 1.** Cresswell Model Data Analysis Techniques

## RESULTS AND DISCUSSION

Based on the results of research during learning related to the concept of "Substance Pressure" continuously, it was found that there was a repeated pattern in shifting representations in connection with the shift in communicative approaches used in science learning in grades 8G and 8H of SMPN 1 Jetis. This can be seen from the results of observations during the concept of substance pressure, in the following table:

**Table 2.** Segment Representation and Code Communication Patterns of Class Knowledge from Substance Pressure Concept Lessons

| Content | No | Date | Description | Representation | Communication |
|---|---|---|---|---|---|
| Tekanan Zat | 1 | 24/01/21 to 07/02/21 | The teacher assigns the activity skill competency assignment 7.1 (investigating the pressure on solids) to answer what factors affect the magnitude of the pressure | NI-D | Active |
| | 2 | | s conducted experiments independently with scenario 1 (pushing coins in the presence of different surface areas), scenario 2 (pushing coins vertically in the presence of differences in the given force) | NI-D | Active |
| | 3 | | Teachers instruct s to represent their observations using photographs | NI-D | Iconic |
| | 4 | | s submit photos and write their observations in their respective assignment books | NI-D | Symbolic |
| Tekanan Zat Padat | 5 | 26/01/21 | The teacher explains the substance pressure material through PPT and learning videos | NI-O | Symbolic |
| | 6 | 03/02/21 | Teachers assign knowledge competencies consisting of 20 multiple-choice questions and 10 description questions that are done in their respective task books | NI-D | Symbolic |

The assignment of skills given by teachers to answer factors that affect the magnitude of solid substance pressure describes an action-based active representation because it produces a concrete stage of real pupil engagement with instructional representations given by teachers to build a conceptual understanding of pupils starting by asking questions, making hypotheses, processing data, making conclusions, and building theories related to solid substance pressure. This is in accordance with the explanation of Yore & Triagust in (Kubasko et al., 2008) which defines instructional representation as certain forms of expression such as written text, analogies, equations, tables, graphs, diagrams, and simulations to convey a specific subject matter. From this instructional representation, a dialogical nature of class communication is generated, with the multiplicity of scientific ideas of pupils to answer the factors that influence the pressure of solids. This is in accordance with the explanation (Buty & Mortimer, 2008) that dialogical communication occurs when the teacher produces learning that aims to attract the ideas of pupils so that there is an exploration of scientific ideas during this learning segment. This segment of representation and communication patterns also occurs in learning number 2 (Table 2).

Furthermore, in learning segment no. 3 (Table 2) when the teacher gives instructions to the pupils to represent their observations using photographs, generated iconic representations, as described (Buty & Mortimer, 2008) iconic representations involve images that resemble concrete situations. The resulting class communication leads to dialogical communication. And for the segmentation of learning no 4,5,6 when the teacher uses symbolic representations, which are based on the involvement of written words and symbols, class communication leads to dialogical and mutritative types of communication alternately (Table 2). The affirmation of each representation and type of communication of classroom knowledge based on the responses of 64 pupils using questionnaires, obtained an average of 3 scales, which showed the scale at the "frequent" level and lasted continuously for a certain period during the course of science learning.

The quality of representation competencies produced by pupils after being measured using a representation knowledge test obtained an average of 81.25 student representation abilities with existing representation indicators: 1) connecting learning experiences, 2) having problem-solving skills, 3) synthesizing information, and 4) visualizing. Where the highest indicator obtained is to synthesize information with an average participant score of 85.3, and for indicators connecting learning experiences and visualizing still need to be improved again with an average student score of 72 (Table 3).

**Table 3**. Average Score Results Of Pupils' Representation Ability Scores

| No | Indicator | Score |
|---|---|---|
| 1 | Connecting learning experiences | 72 |
| 2 | Have problem solving skill | 78 |
| 3 | Synthesize information | 85,3 |
| 4 | Visualize | 72 |
| | Average | 81,25 |

On the indicator connects the experiences of previous pupils, in which they orient their thoughts and actions, this is seen as an active mode of representation (Hilton & Nichols, 2011). According to Prain & Tytler in 2012 the representation of pupils at the intermediate level depends on the experiences of previous pupils. So that as much as possible the teacher is based on previous knowledge in the use of various types of representations that exist. From here representation is seen as a result in teaching and learning that leads pupils to certain learning objectives. Johansson and Wickman in 2011 then explained the purpose directed by the use of representation in teaching and learning divided into two, namely the closest goal (relates to representations based on previous experiences of pupils) and end goals (relates to the objectives of new scientific ideas resulting from representations used in the learning process) (Olander et al., 2018). In the indicator of representation ability to connect learning experiences, an average score of pupils was obtained of 72.

Second, the ability to develop problem-solving skills that can be applied in new contexts. In problem-solving skills, pupils go through the stages of interpreting, analyzing, evaluating, explaining, sorting, reasoning, comparing, questioning, concluding, hypothesizing, assessing, testing, and finally generalizing to solve the new problems they face. The average score of pupils' achievement on this indicator of problem-solving skills is 78, in a good category. In making their own representations, pupils are productively limited in their reasoning by having to focus on key aspects of the problem, choose appropriate tools, and apply background knowledge relevant to the problem. Furthermore, research that puts forward problems in terms of learning, Furtak and Shavelson in 2009 have presented preliminary evidence that instead of consisting of one dominant communicative approach, a mixture of communicative approaches would further facilitate pupil learning (Lehesvuori et al., 2019).

Third, the indicator of synthesizing information is to give freedom to pupils to produce their representations, then pupils unite and organize in an effort to support pupils to synthesize in various reference materials into one coherent representation. The average score of student achievement in synthesizing information is good, which is 85.3 and is the highest indicator of representation.

The ability of representation in the last indicator is to perform visualization, relating to internal representations (mental production, storage and use of images and external representations (displaying systematic and focused public information in the form of images, diagrams, tables, and the like). The score for the indicator of performing visualization was obtained an average of 72. The ability to visualize as a process of knowledge production and the growth of science. The role of visualization in science, in particular with regard to the presentation of visualization as part of scientific practice. As Ruivenkamp & Rip explained in 2010 that visualization is a core activity of scientific practice. Visualization in science includes complex processes through which scientists develop or produce images, schemes and graphic representations, and therefore, what is important in this process is not only the results but also the methodology used by scientists, that is, how these results are produced (Evagorou et al., 2015). Visualization and learning with representation is widely recognized by science educators as a means to promote the understanding and transfer of science, often regarding its systems and processes.). Gilbert in 2008 defined visualization as the creation of the meaning of representation. Visualization deals with external representation, a systematic and focused display of public information in the form of drawings, diagrams, tables, and the like. It also deals with internal representations, mental production, storage and use of images that are often the result of external representations (Eilam & Poyas, 2010).

For a simultaneous and coordinated shift of knowledge representation and communication in learning the concept of substance pressure in class 8G and 8H SMPN 1 Jetis is illustrated visually in the following diagram image:

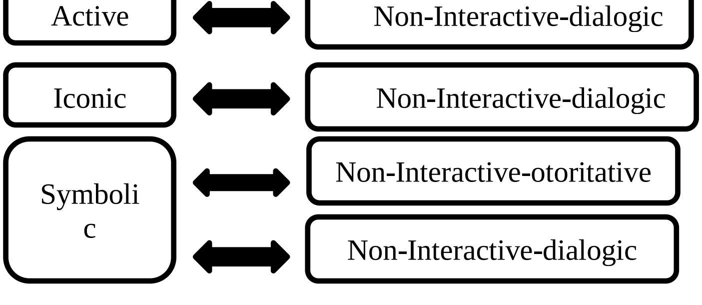


**Figure 2**. Findings: A Shift between Representation and a Communicative Approach to the Classroom

a. Active-Iconic Representations influence Communication in a non-Interactive-Dialogical direction

At the first meeting (called substance pressure skills competency assignment in lessons) where the teacher concentrates the class conversation through assignments with written language instructing the investigative activities that pupils must do until a predetermined deadline (February 7, 2021, at 11:59 pm) through google classroom. The teacher asks the pupils to predict and explain the factors that influence the magnitude of the substance stress. Pupils then build their own scientific concepts individually. All pupils' responses, which are visible from the observations of individual experiments carried out, have been able to explain that the magnitude of the force exerted on the body is proportional to the magnitude of the pressure generated and reverse direction with the surface area on which the force acts. The knowledge that pupils acquire through experimentation with this authentic experience is capable of generating this type of deep knowledge, as Jones et al., argue that pupils can acquire a deeper and more effective type of knowledge when touching and manipulating objects than they can from sight and sound alone. Many argue that direct experience is an integration part of the investigation. But Crawford warned there were obstacles in equating inquiry-based instruction with only the traditional form of direct instruction. Conceptual developments may never occur in traditional direct experience alone. Crawford noted that during traditional science activities, s engage in investigations and answer predetermined questions using the lens of the activity designer. s can carry out investigations and collect data from their observations, but the nature of science in this context is conveyed as a static and unchanging truth, not a tentative product of scientific research promoted in authentic inquiry-based activities in which pupils ask questions, design their own investigations, and draw conclusions based on their data (Kubasko et al., 2008).

Furthermore, regarding the relationship of the types of active and iconic representations that generate non-interactive – dialogical communication, Tang explains that one of the reasons is that active and iconic representations (e.g. gestures, objects, images) are the most common and better known representations of pupils, so this explains why these types of representations are used to attract pupils' ideas in the early stages of learning. In addition, another reason is that active and iconic representations are not suitable for generating authoritative communication in communicating knowledge this is because the discourses and ideologies of science tend to prefer language forms and more abstract representations, in accordance with Lemke's understanding that views language as the main builder of knowledge (Tang, 2016). Apa pun alasannya, kedua alasan tersebut menyiratkan bahwa representasi aktif dan ikonik sebagian besar digunakan untuk menghasilkan komunikasi dialogis yang menarik hubungan keterlibatan dengan peserta didik dalam membangun ide-ide awal.

b. Symbolic Representation affects Communication in the Direction of non-Interactive Authoritative and non-interactive-Dialogic

In addition to submitting experimental documentation individually, pupils were asked to explain how the influence of surface area and force affects the magnitude of solid pressure. From the experiment, the representation model was transferred from an iconic -based representation (image) to a symbolic (language) as the teacher requested from the skill task to find out the factors that influence the magnitude of the tenancy of solid substances. The following is the statement given by participant IV after conducting the experiment assigned by the teacher:

*"the greater the force and the narrower the area of the footing, the greater the pressure generated, on the contrary, the wider the compressive field, the smaller the pressure"*

**Figure 3.** The Magnitude of Pressure Generated from Different Surface Areas

**Figure 4.** The Magnitude of the Pressure Resulting from the Magnitude of Different Forces

From figure 3 it can be seen that the participants performed scenario 1 (pushing the coin in the presence of a different surface area). Parisipan wrote in his assignment book that:

*"The vertically driven position of the coin generates greater pressure, because the surface of the metal money facing plasticine is narrower so that the push marks become deeper. This event has to do with pressure. The pressure generated by a metal money with a vertical position will be greater than that of a horizontal position"*

Furthermore, in figure 4, it can be seen that the participant performed scenario 2 (pushing the coin vertically in the presence of a given difference in force). The participant wrote in his assignment book that:

*"from a large force thrust will result in greater pressure and a deeper thrust mark "*

From the experiment, the representation model was shifted from an iconic -based representation (image) to a symbolic (language) as the teacher asked from the skill task to find out the factors influencing the magnitude of the solid substance tenancy by writing down the description using their own words in the assignment book. Effectively, they must re-represent or change their observations from active mode after conducting experiments and documentation results from iconic mode to written language in symbolic mode.

From this segment, it generates classroom communication of a non-interactive nature, due to the absence of interaction that occurs between pupils, since the assignment of skills given by the teacher is instructed to be carried out individually. In this case, written language becomes the dominant representation model that mediates dialogical interaction, since all ideas are accepted by the teacher in the work on the competence of this skill. Pupils' conversations and actions center on written responses as a result of experiments they submit to google classroom individually.

This segment ends by maintaining a dialogical communication pattern because the pupils' ideas are still accepted entirely and the teacher has not incorporated the accepted scientific ideas into the classroom talks. In addition, in this learning segment, the teacher asks pupils to draw and explain according to the representations built by themselves, as well as being asked to provide an explanation of what pressure is in their own opinion. So it can be known that pupils build their own symbolic (verbal / language) representations of mathematical representations related to pressure formulas, in which the magnitude of the pressure formulated is equal to the magnitude of the force exerted and is inversely proportional to its surface area.

After conducting experiments as skill assignments, the teacher continues learning by sending ppt and learning videos related to the overall stress of substances that also use symbolic represetations. Unfortunately, there is no class discussion conducted with the teacher to discuss the misconceptions found in the field, thus directing class communication to an authoritative model in which there is only 1 idea heard, namely from the teacher as a whole. To relate the entire segmentation that exists the teacher only gives material in general and the assignment of knowledge competencies to find out the extent of the pupils' understanding of the concept of substance pressure.

From here, there is a shift in the type of communication from dialogical to authoritative using 1 type of representation, namely the symbolic representation of language brerbasis. The reason why the shift of both types of communication occurs with the symbolic representation model is due to the flexibility of the language that mediates the transition. As the teacher does when sending material on the concept of substance pressure through ppt and learning videos where there is only 1 idea heard, namely from the teacher as a whole through the language of science which the teacher uses as the only medium of conveying scientific ideas so that authoritative class communication is formed. And when the teacher uses written language that instructs students to produce scientific ideas through a series of predetermined experimental activity instructions, then flexibly symbolic representations can be directed to produce authoritative and dialogical class communication. This is in accordance with Bruner's explanation, which views language as having the flexibility to direct class discussions to authoritative and dialogical communication models (Tang, 2016).

## CONCLUSION

Based on the foregoing, it can be concluded that: 1) science learning at SMPN 1 Jetis is mediated with three types of representations that exist, namely active, iconic, and symbolic alternately and simultaneously. The representation ability of students of SMPN 1 Jetis during the learning of the concept of substance pressure reached an average score of 81.25 in the category of excellent representation ability; and 2) the shift of the three patterns of combination of representations that exist in science learning at SMPN 1 Jetis directs learning to dialogical and authoritative communication patterns.

This research is expected to theoretically and practically provide benefits to readers. The theoretical benefits of this study explain certain representation patterns governing meaningful classroom communication so as to add information related to representation for educational researchers. Practically pupils can inform their representational abilities, thereby encouraging pupils to improve their achievement abilities, and allowing teachers to become more skilled in using representation to mediate classroom discourse and manage meaningful classroom talks during science teaching sequences.

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