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A Semiotic Analysis-Based Science Teaching Materials Development Training: Perceptions and Challenges of Teachers in Indonesia

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Abstract

Individual teachers are responsible for professional development that is consistent with scientific, social, and educational advancements. Individual teachers can improve their potential to function as learning agents by reflecting on their daily classroom experiences or brainstorming with colleagues about ways for planning, practicing, and evaluating learning. The purpose of this study is to investigate the perceptions and challenges of junior high school science teachers regarding a semiotic analysis-based science teaching materials development training program. The data collection methods included a customized questionnaire, focus group discussions, and depth interviews. According to the findings, teachers reported having the opportunity to improve their lesson plans through semiotic analysis and the development of science teaching materials. Among the issues and challenges they identified was a lack of comprehension of how to examine a text's information density, abstraction, complexity, and authoritativeness, poor writing abilities, and difficulty adapting to newly designed semiotic-based science teaching materials. The study suggests that policymakers and educational organizations encourage science teachers and help them become more effective teachers across the nation.

Keywords: development training program, science teacher, semiotic analysis, teachers' perceptions.

Introduction

Teachers in contemporary culture must be professionally trained to meet high standards, possess pedagogical and practical skills, and promote ethical and moral principles. Teachers have a critical role in establishing and sustaining a school's identity, supporting students' accomplishments, and promoting educational equity. Without renewing or upgrading teachers' skills and knowledge, teachers may be unable to engage students in learning in order to equip them with the necessary skillsets for competitive life in current society (Huseynova, 2019).

Developing teacher performance in accordance with contemporary advances is based upon teachers' ability to stay current. In comparison to many other occupations, teaching takes extra work and attention. Additionally, teaching is a career in which dedication is required for development. If a lack of in-service teacher training contributes to teachers' inadequate professional development and widens the gap between expectations and actual achievement levels (Osamwonyi, 2016).

In-service teacher training is widely used throughout the world, with the idea that it helps teachers advance their professional development. Furthermore, the training has been implemented in order to promote continuous improvement of teaching staff, eliminate differences in teachers' educational backgrounds, keep the teaching profession abreast of new knowledge, enable the realization of creative innovations, and assist teachers in dealing with the responsibilities associated with the changing learning environment (Osamwonyi, 2016). In this regard, it seems that in-service training is a necessary component of teachers' professional development (Saleem & Zamir, 2016).

The idea of teacher training may be interpreted in a variety of ways, including participating in productive learning as a successful and active participant, serving as a counsellor, or serving as a policymaker (Loughran, 2014). In-service teacher training is undertaken with the main aim of ensuring that the capability of academic institutions and the whole education system continues to develop over time (Union, 2013). In-service teacher training is thus defined as a critical component of the professional development of teachers that has been adopted by policymakers and education departments in order to orient teachers and equip them with skills aimed at improving the quality of educational opportunities for all students. Teacher training is accomplished through mentorship, coaching, collaborative projects, syllabus development, and the exchange of best practices. Teachers are at the epicentre of the educational process. Thus, teacher training policy is a component of contemporary education development and is critical for promoting continuous learning (Loughran & Berry, 2005).

During the training, participants experience a shift in their attitudes and behaviours, as well as in their knowledge, skills, and abilities. The training is geared toward cultivating the professional etiquette required by teachers in order to perform adequately at specific tasks (Guskey, 2014). As a result, in-service teacher training is a capacity-building activity that promotes organizational growth and development (Omar, 2014).

According to the findings of a study conducted by Lingam (2012) on teacher perceptions of the training program, teachers have a good attitude toward the training that they participate in. Another issue that was discovered was that some teachers in this training program are also concentrating on developing some problems. Further research of prospective teachers' perceptions of the training program was carried out by (Nenty et al., 2015), who found that prospective teachers were satisfied with the efficacy of the training programs that had been implemented. The researchers further said that the more positive teachers' perceptions of teaching as a profession were, the more positive their perceptions about teacher training programs were also.

Originally, language was seen to be only a medium for the transmission of ideas or the transmission of reality. Systemic functional linguistics reconceives language as a semiotic instrument that is integrally engaged in the negotiation, production, organization, and reconstruction of human experiences (Halliday, 1978); (Hasan & Martin, 1989). Language choices (i.e., grammar) are shown to contribute in a systematic manner to the reality of social settings. According to this view, language is more than just a means of conveying meaning; it is also a primary source of meaning creation. Moreover, it is a component of reality, a formative agent in the formation of reality, and a metaphor for reality (Halliday, 1993a.).

From the viewpoint of functional linguistics, studying the specialized language of science is equivalent to learning science. Language is a fundamental prerequisite of learning, according to, and "learning is the process by which experience is transformed into knowledge". Learning science entails being proficient in the management of the distinctive language forms and structures that are used to develop and express scientific ideas, information, and beliefs, among others. It is feasible for scientists to build an alternative interpretation of the physical world to that given by the common sense language of daily spontaneous speech owing to the specialized grammar of the scientific language (Halliday & Martin, 1993); (Martin & Veel, 1998)).

Almost all previous research on semiotic analysis has focused on studies related to students, textbooks, and other learning media. For example, the results of research on the use of content analysis and lexicogrammar analysis enable the integration of scientific and linguistic perspectives in order to comprehend the needs of science learning using language (Seah et al., 2013); Teachers should aid students in overcoming language difficulties associated with defining density disparities, which complement the findings of previous research focusing on conceptual difficulties (Seah et al., 2015); The critical impact that students' perceptions of their vocabulary knowledge, vocabulary and reading methods, and reading strategies play in science subject learning (Brown & Concannon, 2016); In connection to student accomplishment in science subjects, the home language and literacy in the language of instruction (Van Laere et al., 2014); and using systemic functional analysis to investigate the language of climate change chapters in science textbooks (Román & Busch, 2015). However, there is still little about teacher training in developing teaching materials based on semiotic analysis.

This study explores and discusses the perspectives of science teachers in Indonesia on semiotic analysis-based teaching materials development training, as well as the issues and obstacles they face. Consequently, the objective of this study is to establish how science teachers perceive semiotic analysis-based teaching materials development training and what obstacles they face in this process. As a consequence of this study, policymakers at the Ministry of Education should be better equipped to make sound judgments concerning teacher training programs. As a result, the following questions are posed in this study:

1. What are the perceptions of the teachers who participated in the semiotic analysis-based science teaching materials development training program?
2. What are the issues and challenges that teachers who participated in the semiotic analysis-based science teaching materials development training are encountering?

Methodology

This paper described a descriptive study to gather science teachers' perceptions and challenges about the semiotic analysis-based science teaching materials development training program. The study took place at a junior high school in West Java, Indonesia, and included 39 science teachers with undergraduate and master's degrees (31 females, 8 males; 25-58 years old; 5-25 years of teaching experience). Some of them did not have a background in science education for master's degrees (physics, biology, or chemistry), but they always participated in training programs. This contextualized survey, conducted in an Indonesian context, will enrich research on teacher perception and challenges of the training program in developing semiotic analysis based teaching materials development for future learning.

The data for this study was collected between August 2021 and October 2021 and was taken from a questionnaire, a focus group discussion and doing an informal interview in order to get depth analysis.

The questionnaire consisted of twenty-five items of open-ended questions, which were addressed to answer the first research question toward science teachers' perception regarding teaching materials development training for semiotic analysis based. Moreover, in analyzing the data, the writer used frequency numbers. The questionnaire is divided into five parts question. The information is gathered by open-ended questions. Part of this questionnaire are:

1. Teacher training (question 1-3)
2. Vibration and wave matter (question 4-5)
3. Semiotic analysis matter (question 6-7)

4. Lesson plans (question 8)
5. Semiotic analysis-based teaching materials development (question 9-10)

Both the questionnaire and the focus group discussion were conducted in a two-hour session. First, the participants answered the questionnaire individually and anonymously for 30 minutes. Then they were grouped into ten five- or six-member groups for a focus group discussion. They met for 30 minutes with a moderator (the researcher). They discussed problems making science teaching materials with semiotic analysis based and the need for using it, their perceptions of semiotic analysis in science learning, the training program. The teachers presented a summary of their group's ideas in the next meeting, which lasted for an hour. Each group was given 10 minutes for their presentation. They also presented some suggested solutions and gave recommendations to the issues and challenges noted during the focus group discussion—lastly, 60-minutes interview by the researcher for 3 participants.

Results

This part is concerned with data analysis regarding findings and discussion and interpretation of the findings. The perspectives of the teachers who participated in the semiotic analysis-based science teaching materials development training program are the first problem in this research. Teachers' perceptions were collected through questions in a questionnaire about teacher training, vibration and wave matter, semiotic analysis matter, lesson plans, and semiotic analysis-based teaching materials development. The following table shows the frequency of teachers' answers and responses to questions about teacher training.

Questionnaire part 1 on teacher training

Table 1. Frequency of attending and teachers' reasoning on teachers' training

Concepts	Frequency
Attending teachers' training.	39
Attending teachers' training in developing of science learning materials based on semiotic analysis.	0
The importance of training for science teachers	39
Teachers' reasoning:	
1. Increasing an individual's capability.	9
2. Continuing Professional Development.	9
3. Enhancing curriculum-based knowledge.	6
4. Providing hands-on experience in effective teaching practices.	3
5. Improving teaching ability.	4
6. Obtaining new knowledge and information.	5
7. Using plans to learn about innovation.	3

Questionnaire part 2 on vibration and wave matter

Table 2. Teacher's understanding of the concepts of vibration and waves

Concepts	Responses	Frequency
Vibration and waves.	• Difficult to understand because my educational background in Biology/Chemistry	5
	• The concept is abstract	2

Concepts	Responses	Frequency
	• Complicated	3
The matter provided can help me to design science learning materials.		29

Questionnaire part 3 on semiotic analysis matter

Table 3. Teacher's understanding of the concepts of the semiotic analysis

Concepts	Responses	Frequency
The semiotic analysis.	• The semiotic analysis is a new thing for me. • The concept is abstract. • Complicated.	21 1 14
The matter provided can help me to design science learning materials.		3

Questionnaire part 4 on lesson plans

Table 4. Difficulties in designing a lesson plan

Difficulties	Frequency
Decide a model of learning that fit with science concepts/ matters. 2. Models of learning and core activity. 3. Indicator and apperception. 4. Matter analysis, indicator and assessment. 5. Instrument assessment. 6. Evaluation and method.	1 1 1 2 1 1

Questionnaire part 5 on semiotic analysis-based teaching materials development

Table 5. Designing learning materials based on semiotic analysis

Concepts	Responses	Frequency
The modules and worksheets are provided during training.	Assist in making teaching materials. Quite difficult to make teaching materials.	15 24
Difficulties in designing learning materials based on semiotic analysis.	Calculating lexical density. Define text abstraction per paragraph. Determine the technicality of the text per paragraph. Determine the authoritativeness	1 10 15 15

The second problem is the issues and challenges that teachers who participated in semiotic analysis-based science teaching materials development training are facing. A focus group of 39 participants who were divided into five groups of seven or eight members was organized to better understand perceptions of the teachers' training and challenges, which were assessed by the questionnaire. Participants exchanged opinions on a variety of topics, including the issues, challenges, and potential solutions.

One of the important issues about teacher training programs that arose during the focus group discussions was teaching materials on semiotic analysis. Another challenge experienced by teachers is the difficulty of adapting in making teaching materials based on semiotic analysis because it is a new thing.

Discussion

Based on Table 1 for the question: “Have you ever attended a science teacher training?” all 39 participants stated that they had attended teacher training. As for the question: "Have you ever attended training in developing of science learning materials based on semiotic analysis before?" all of them stated that they had never attended at all. In fact, they only knew about semiotic analysis. In their perspective, training increases their capability. Some of the participants attended teacher training because of their responsibilities. Teacher training is highly crucial for career advancement. Professional development programs fill up the gap between program and practice at school. There are two key concerns that should be in teacher training: content knowledge and reflective practice. Teachers could construct content knowledge science subjects using a variety of different reflection processes and methodologies, given each case study's experience and prior knowledge is unique. Additionally, the requirement for self-development varies with every content knowledge element. This may necessitate the use of a variety of techniques, including self-reflection on the situation, self-assessment, and learning notes (Thiliworrakan & Ladachart, 2021). The first question and second one might be a suitable start-up for a new training program. For the third question about the importance of teacher training, there are seven reasons from the participants, which can be seen in Table 1. When it concerns teacher learning, there are two crucial aspects to consider: what is learnt and how it is taught (Coenders & Terlouw, 2015). When it comes to what has been learnt, they are PCK (Pedagogical Content Knowledge) as a foundation for orienting scientific instruction, knowledge and belief about science curriculum, knowledge and belief about the comprehension of particular subjects, among other things. It is described in four domains: teacher knowledge, belief, attitude; practice concerning professional experimentation; consequence encompassing to know the result; and external sources of information (or sources of information from outside the classroom).

The fourth questioning is designed to elicit information about the problematic science concept or subject. Table 2 has an inventory of challenging concepts. Ten participants explain why the subject is challenging due to their disparate educational backgrounds. For instance, they lack comprehension of physical concepts due to their scholastic background in Biology or Chemistry. The vibration and wave concepts are challenging because they are abstract and complex. Thus, the majority of participants, or twenty-nine, indicated that the substance of wave vibration is not difficult. Concerning the fifth question, which asked if the content presented might assist them in developing science learning materials, all participants agreed that the training materials could assist them in developing teaching materials. Teacher efficacy is necessary in order for a science teacher to be confident in front of the students. To boost self-efficacy, science teachers must gain knowledge of all science subjects, and teacher training might be beneficial. Teachers' academic knowledge, pedagogical expertise, and experience all influence their self-efficacy and implementation in teaching science (Kaya et al., 2020).

Part 3 of the questionnaire consists of two semiotic analysis questions. The sixth question concerns the teacher's understanding of the semiotic concept. Almost everyone said it was difficult to comprehend. Table 3 illustrates this. Twenty participants stated that using the semiotic concept to science learning was novel. According to fifteen additional participants, the concept of semiotics is difficult and abstract. Only three participants responded to the seventh question on how the concept of semiotics may help in the creation of science teaching materials. In fact, if the teacher knows semiotics, it will produce teaching materials that students can readily understand. Students who are unfamiliar with science's particular meaning-making grammatical resources are likely to have problems when reading and to write science texts (Fang, 2005).

The difficulty in developing lesson plans is discussed in question eight. "Are there any difficulties in developing lesson plans?" The majority of responders indicated that they had no difficulty developing lesson plans (Table 4). Seven participants indicated that it is challenging to do subject analysis, indicator development, and evaluation due to the diversity of student characteristics. They demonstrate difficulty in selecting a model of learning that is compatible with scientific concepts/matter, models of learning and core activities, indicators and perception, matter analysis, indicator and assessment, instrument assessment, and evaluation and procedure. The majority of thirty-two participants felt that creating lesson plans was simple. Science teachers must be innovative in their approach to science learning, including teaching methods, instructional materials, and evaluation. Teachers working under supervision are capable of developing creative teaching materials. The development of teaching materials can help teachers acquire teaching materials more effectively, as well as increase their academic and material expertise, and eventually, they can help improve the learning process (Ruhiat et al., 2016). To develop innovative teachers, teachers must master PCK consisting of five components: orientation to science education, knowledge of science curricula, knowledge of scientific literacy assessment, knowledge of students' scientific literacy comprehension, and knowledge of instructional methods (McNeill et al., 2015). As a result, teacher training as a kind of professional development can help encourage PCK and innovation in teaching materials, methods, and development.

The purpose of the ninth question is to gather information from participants about the modules and worksheets provided during training. From the participants' answers, there were fifteen teachers who stated that the modules and worksheets could help them in making teaching materials. The remaining 24 teachers stated that the training materials were rather difficult to help them in making teaching materials. The last question is to collect information from participants about difficulties in designing learning materials based on semiotic analysis. All participants expressed difficulties in designing teaching materials based on semiotic analysis. Their reasons can be divided into four groups of responses, namely calculating lexical density, defining text abstraction per paragraph, determining the technicality of the text per paragraph, and determining the authoritativeness.

In this teacher training, participants make science teaching materials based on semiotic analysis. According to (Fang, 2005) there are four characteristics of scientific writing based on systemic functional linguistic theory, namely informational density, abstraction, technicality, and authoritativeness. The following is an explanation of the reasons for the difficulty of participants in developing science teaching materials from each characteristic of scientific writing.

Informational density

One of the characteristics of scientific writing that sets it apart is its great information density. A text's information density can be quantified using a metric called "lexical density." Lexical density can be computed in two ways: (a) as the number of content (i.e., lexical) words per unembedded phrase (Halliday, 1993d); or (b) as the ratio of content words to total running words (Halliday, 1993d) (Eggins, 1994). Nouns, the main component of the verb, adjectives, and certain adverbs are content-carrying words; prepositions, conjunctions, auxiliary verbs, some adverbs, determiners, and pronouns are noncontent-carrying words (Eggins, 1994). Typically, a clause contains participants (represented by nouns), processes (represented by verbs), and context (represented by adverbial or prepositional phrases) (Eggins, 1994). In scientific writing, the clause contains a greater number of content words; in daily spontaneous speech, noncontent words comprise a large portion of the clause. According to (Halliday, 1993d), in daily spontaneous speech, each clause typically contains two-three content words; yet, in written language, each clause contains four-six content words. This amount can increase significantly in scientific writing, reaching as high as 10–13 content words per phrase.

Abstraction

In contrast to the commonsense language used to describe everyday life experiences, scientific language abstracts concrete life experiences into abstract entities that can be examined and critiqued further. This type of thinking entails recasting processes (as articulated through verbs and adjectives) as participants (as expressed by nouns). The process by which verbs or adjectives are transformed into nouns is referred to as "nominalization" (Halliday, 1998). According to (Christie, 2001), nominalized words "abstract from immediate, lived experiences in order to construct facts, abstractions, generalizations, and arguments," allowing them to participate more fully in the process. The author can utilize nomenclature to invent new technical names or entities, establish causal links between unrelated occurrences, and synthesize and standardize previously expressed information (Veel, 1997).

Technicality

Technical proficiency is required to realize science's specific contents. In science, the practice of "technicalizing" often entails the use of technical terminology and verbs describing relational processes. Technical jargon refers to "expressions or words... with a particular field-specific meaning" (Wignell et al., 1993).

Authoritativeness

In science, information is often delivered objectively and accurately, with an authoritative tone (Schleppegrell, 2001). To accomplish this, the author must disassociate himself/herself from the text by avoiding (a) first-person references (e.g., I am writing...), (b) references to his/her mental processes (e.g., I believe, I suppose...), (c) discourse fillers for monitoring information flow (e.g., you know...), (d) direct quotes (e.g., it says, "I am tired."), and (e) ambiguity and hedges (Chafe, 1982). Authoritativeness is often conveyed in scientific writing through the use of specialized, rather than commonplace, vocabulary and declarative, rather than imperative or interrogative sentences. When combined, these grammatical resources permit "the emergence of an assertive author who presents himself/herself as a qualified expert offering [correct and] objective information" (Schleppegrell, 2001). Scientific language is distinguished from the more informal and engaging language of everyday life by its authoritative nature. To pupils who are accustomed to the more familiar and engaging language of everyday spontaneous speech, it appears both impersonal and alienating.

The majority of participants can follow and comprehend the training material on developing teaching materials based on semiotic analysis. However, they continue to struggle with the concept of semiotics because this is the first time they have attended semiotics training. The issues and challenges experienced by participants were identified during the focus group discussions summarized below.

One of the critical issues raised during the focus group discussions about teacher training was the need for teaching materials on semiotic analysis. This is an issue that affects all participants. They are not familiar with studying semiotics, which is the knowledge that is beyond their competency and is considered new.

Another challenge that participants encountered was the difficulty of applying semiotic knowledge into the development of teaching materials. In other words, they are required to construct science teaching materials using semiotic analysis in order to analyze the information density, abstraction, technicality, and authoritativeness of a text or teaching material during their training.

Participants were generally pleased to be a part of the teacher training program and to expand their expertise in developing instructional materials. Although some issues were uncovered throughout the interviews and group discussions, they were extremely pleased with the program's outcomes at the conclusion. Recognizing some of the challenges and concerns and proposing answers in the training program, as well as improving participants' skills in applying semiotic analysis, means that teachers require training in developing instructional materials based on semiotic analysis. More precisely, this study demonstrates that school leaders and the government, notably the Ministry of Education, should place a greater emphasis on training in the development of semiotic-based science teaching materials, not only in West Java Province but across Indonesia. Further research can be conducted on additional science teaching materials, not just vibrations and waves. Extensive research on teacher issues with semiotics-based teaching materials should be conducted after the conclusion of the training program year to ascertain teachers' improvement and to determine whether their perspectives of the training program have changed learning among students regarding the academic concepts and enabling them to achieve their goals and objectives

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Imparting learning among students regarding the academic concepts and enabling them to achieve their goals and objectives

Conclusion

This study aims to determine teacher perceptions of teacher training programs in the development of science teaching materials based on semiotic analysis. The findings indicated that teachers had a favourable opinion of this program as a result of their involvement in the study of various resources for the development of instructional materials. Additionally, they believed that their comprehension of vibrations and waves, lesson plans, and semiotic analysis had increased since they began the teacher training program. These findings, however, are confined to science teachers who were participated in a training program.

Because teachers are responsible for the education in the classroom, training them in semiotic analysis-based science teaching materials development is an excellent technique to prepare them to improve their qualifications. However, certain concerns and challenges should be considered in order for students to gain a better understanding of themselves and the changes they will encounter in the classroom. Thus, it may be beneficial for the regional Ministry of Education, educational organizations, and policymakers to address some of the issues and challenges in order to guide and encourage science teachers and assist them in becoming better educators.

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