

# Applying innovative approach “Nature of Science (NoS) within inquiry” for developing scientific literacy in student worksheet

*by Asri Widowati*

---

**Submission date:** 01-Oct-2018 04:24PM (UTC-0400)

**Submission ID:** 1011837894

**File name:** Widowati\_2018\_J.\_Phys.\_3A\_Conf.\_Ser.\_983\_012199.pdf (605.92K)

**Word count:** 3226

**Character count:** 18285

PAPER • OPEN ACCESS

## Applying innovative approach “Nature of Science (NoS) within inquiry” for developing scientific literacy in the student worksheet

To cite this article: A Widowati *et al* 2018 *J. Phys.: Conf. Ser.* **983** 012199

View the [article online](#) for updates and enhancements.

### Related content

- [The Development of Scientific Literacy through Nature of Science \(NoS\) within Inquiry Based Learning Approach](#)  
A. Widowati, E. Widodo, P. Anjarsari *et al.*
- [Innovative approach towards understanding optics](#)  
Amit Garg, Sadashiv Raj Bharadwaj, Raj Kumar *et al.*
- [Improving Middle School Students' Quantitative Literacy through Inquiry Lab and Group Investigation](#)  
N S M Aisya, B Supriatno, Saefudin *et al.*

# Applying innovative approach “<sup>5</sup>Nature of Science (NoS) within inquiry” for developing scientific literacy in the student worksheet

A Widowati<sup>1</sup>\*, P Anjarsari<sup>1</sup>, K P Zuhdan<sup>1</sup> and A Dita<sup>1</sup>

Science Education Department, Yogyakarta State University

\*Corresponding author: asri\_widowati@uny.ac.id

**Abstract.** The challenges of the 21st century require innovative solutions. Education must be able to make an understanding of science learning that leads to the formation of scientific literacy learners. This research was conducted to produce the prototype as science worksheet based on Nature of Science (NoS) within inquiry approach and to know the effectiveness its product for developing scientific literacy. This research was the development and research design, by pointing to Four D models and Borg & Gall Model. There were 4 main phases (define, design, develop, disseminate) and additional phases (preliminary field testing, main product revision, main field testing, and operational product revision). Research subjects were students of the junior high school in Yogyakarta. The instruments used included questionnaire sheet product validation and scientific literacy test. For the validation data were analyzed descriptively. The test result was analyzed by an N-gain score. The results showed that the appropriateness of worksheet applying NoS within inquiry-based learning approach is eligible based on the assessment from excellent by experts and teachers, students' scientific literacy can improve high category of the N-gain score at 0.71 by using student worksheet with Nature of Science (NoS) within inquiry approach.

## 1. Introduction

Indonesian human resources must have literacy in various fields, include scientific literacy to live independently in society, especially in the face of global competition in ASEAN Economy Community Era. Survey of Program for International Student Achievement (PISA) in 2012, from 65 countries, Indonesia ranked 64th. Furthermore, in 2015, Indonesia rose by six ratings and experienced a significant literacy score of 22.1 in 2015, where science competence only increased one point. This is quite encouraging, but Indonesia still has to struggle to improve the quality of education. Despite Indonesia's increasing literacy, Indonesia is still ranked 62<sup>nd</sup> out of 70 countries by 2015. The further research indicates that almost half Indonesian students of senior high school (41%) have only limited knowledge about science, even there are also Indonesian students (6.9%) who do not have scientific literacy [1].

<sup>5</sup>Science education must give a chance for helping students develop an adequate conception of Nature of Science (NoS) and scientific inquiry must as ongoing objective in science. Efforts to develop literacy can be realized if education can develop critical thinking skills, creative, problem solving, and adaptive to developments. The big challenge faced by Indonesia education is how to



<sup>1</sup>

Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](https://creativecommons.org/licenses/by/3.0/). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

strive for human resources of productive age, can be transformed into competent and skilled human resources in order not to become a burden. But education in Indonesia, an understanding of science learning that leads to the formation of scientific literacy learners, seems not yet fully understood well by the teachers of science [2] Literacy of science is the main goal in science education for science education reform can run optimally [3].

An understanding of the Nature of Science (NoS) has a vital role in the development of scientific literacy [4]. Efforts to instill scientific literacy can help students develop an informed conception of the nature of science (NoS) by using a progressive and authentic learning environment. However, the realization of the objective may be missed because of the inactivity of NoS inquiries [5]. NoS as the values and assumptions inherent in scientific knowledge and the development of scientific knowledge [6]. Based on Griffiths & Barry's research, conducted a case study of NoS understanding in junior high school students in Canada where NoS which known that the majority of junior high school students have not understood the NoS aspect [7]. Also, the availability of teaching materials containing Nature of Science (NoS) is explicitly carried out [8].

Inquiry can develop scientific literacy [9] because the inquiry is one of the learning approaches that emphasize active student learning, based on scientific inquiry, and constructivism so it can build scientific literacy. The results indicate that the application of inquiry on science learning has a positive effect on cognitive outcomes, process ability, and scientific attitudes towards [10]. Also, the inquiry also provides an opportunity for teachers to explore ideas and experiences to students, identify concept errors and direct students using events and logic [11]. Literacy of science closely related to inquiry and NoS. The effort to develop scientific literacy requires an understanding of subject matter, Nature of Science (NoS) and inquiry [6]. What challenges teachers is how to integrate these three aspects by applying an innovative approach that teaches science using NoS charged inquiry. This approach integrates the inquiry approach with NoS contents to develop more optimal scientific literacy.

To organize a Nature of Science inquiry study (NoS). Organizing NoS within inquiry studies requires learning tools that are designed in such a way. Specific learning tools or Subject Specific Pedagogic (SSP) that not only contain the content of the material but also invites students to inquiry and load knowledge about science related to the nature of science (Nature of Science/NoS). Unfortunately, no such learning tool has been designed.

Based on this background, it is important to develop a scientific literacy development model with NoS within inquiry-based science learning design as an effort to improve the nation's competitiveness in facing the era of MEA. The integration of the inquiry approach and Nature of Science is believed to optimize the scientific literacy [12] further. The purpose of this research especially is to produce scientific literacy development model through NoS within inquiry-based learning design and develop a student worksheet prototype of NoS within inquiry-based learning material. It is important to know the effectiveness of the student worksheet for developing students' scientific literacy.

## 2. Methods

This research design is Research and Development (R&D), by pointing with model Four-D and Borg and Gall. Procedure development of prototype consists of four main phases (phase define, design, develop, and disseminate) and an additional phase (preliminary testing fields, main product revision, playing field testing, and operational product revision) taken from Borg and Gall procedure. This research has been conducting from June to November 2017. The research's subject is the students of the junior high school in Yogyakarta City.

The type of data in this study includes quantitative and qualitative data. The research instruments used were: (1) observation sheet to collect data about student's inquiry skill; (2) Sheet questionnaire validation of Student Activity NoS within inquiry learning approach used to obtain data on product assessment from experts and science teachers of the junior high school, (3) Scientific literacy test, to measure students' scientific literacy. This research data were analyzed descriptively. Scientific literacy test data is also analyzed by paired t-test to determine the effectiveness of the NoS within inquiry approach for improving students' scientific literacy.



### 3. Results and discussion

Based on the observation students inquiry skill result from 211 students of the junior high school, the attainment of junior high school students' inquiry skills is still in enough good category from the preliminary testing field. The preliminary field does through observation of the aspects of student inquiry skill, including make observation note, make question-based on the observation result, make a scientific problem. More than 60% of the student has good skill on making observation note and make question-based on observation. However, for the ability to determine the formulation of problems that can be investigated is still apprehensive because most (48.34%) lack the skill. These results indicate that junior high school students have not been trained to do inquiry.

The curriculum of science learning in the junior high school is still less oriented to the development of scientific literacy. Other than that, NoS is still very rarely delivered in schools. The science teachers do not already have an understanding of the importance of NoS, and how to learn it, the teaching materials used in schools (including curriculum material 2013) have not explicitly inserted the NoS aspect. The curriculum of education in Indonesia still prioritizes aspects of the content and forgets the context and process dimensions as required by TIMSS.

Based on concept analysis, Food Additives is one of the science content that can be used to study scientific literacy. The teaching materials developed in the form of Student Activity Sheets with an experiment type because of the student guide for doing an experiment or observation about Food Additive Substance through this Student Activity Sheets. There are several NoS can be showed explicit and reflective on the Student Activity Sheets. The selection of NoS charges is adjusted to the material characteristics of Food Substance Additives. The NoS aspects that charge in science learning material "Food Additive Substance" is science based on empirical evidence, scientific investigation using various methods, science is a way of knowing, science is the result of human effort, and science answers the questions about nature. Based on the analysis of task analysis, concept analysis, and characteristic analysis of learners, the learning media chose to increase the scientific literacy of learners in the science lesson through NoS within inquiry approaches, such as presentation slides in powerpoint form, and tools and materials for the scientific activities. The science learning material such as Science Student Activities Sheet is also needed in the science learning about food additive substance. The developed Science Student Activities Sheet consists of three learning activities. Activity 1 was titled "Introduction to Additives," activity 2 titled "Identification of Additives on Food Packaging," and activity 3 titled "Test of Borax in Foodstuff."

Learning material in this study was arranged based on Nature of Science (NoS) within inquiry learning approach, it was the combination of inquiry approach and understanding about Nature of Science (NoS). Inquiry approach was facilitated with paying attention to the steps in a worksheet like formulating the problem, formulating a hypothesis, collecting data, analyzing data, taking a conclusion, and generalizing. The explicitly-reflective NoS content in Student Activity Sheets of Food Substance Additive is science based on empirical evidence, scientific investigation using various methods, science is a way of knowing, science is the result of human effort, and science answers the questions about nature. Aspects of NoS are important showed explicitly and reflectively because the understanding of NoS is stated as the one of characteristics scientifically literate person. A scientifically literate person should develop an understanding of the nature of science [13].

The validation process of science learning material based on NoS within inquiry learning approach was done by two expert lecturers and three teachers (practitioners). Based on the data from the questionnaire validity of product, it can be seen that the feasibility category of Science Student Activities Sheet result of development according to the expert lecturer is very good with the value of A. Expert and teacher lecturers give suggestions: (a) improvement of concept map; (b) the formulation of learning objectives should be synchronized with the Basic Competencies to be achieved; (c) the NoS content in the introductory section should be related to the learning activities that the learners will undertake; (d) presentation of activities to better facilitate students in finding concepts, one way by democratizing discussion questions according to their cognitive chain; (e) NoS should also be presented explicitly and briefly to the command phrase within the developed Science Student

Activities Sheet. Validator comments are used as the main reference in the revision of prototype products. The main thing in the revision of NoS load reflection is shorter and more practical to make it easier for learners to understand the content of the NoS. The aspects NoS in Science Student Activity Sheet can be shown explicitly in Figure 1. Science learning material based on NoS within inquiry learning approach was developed and revised based on the relevant suggestions. All expert lecturers and teachers had given assessment that development of science learning material (such as Science Student Activities Sheet) had already used inquiry learning approach including understanding of NoS were taken, inserting investigation with steps of inquiry approach (formulating problem, formulating hypothesis, testing hypothesis, analyzing data, taking conclusion, developing new problem), students had chance to understand the NoS aspects. Besides, validators also stated that the developed science learning material loaded scientific literacy in competency aspect with indicators: (1) explaining phenomenon scientifically, (2) designing scientific investigation; (3) evaluating scientific investigation; (4) making interpretation of scientific proof and data. The scientific literacy in Science Student Activity Sheet can be showed in Figure 2

Figure 1 shows a worksheet page with instructions in Indonesian. It includes a table for recording observations. The table has three main columns: 'Tampilan' (Appearance), 'Rasa' (Taste), and 'Warna' (Color). Under 'Tampilan', there are sub-columns for 'Merasa' (Feel), 'Kurang Merasa' (Less Feel), and 'Lazat' (Tasty). Under 'Rasa', there are sub-columns for 'Kurang Lazat' (Less Tasty) and 'Merusak' (Damaged). Under 'Warna', there are sub-columns for 'Kurang Merusak' (Less Damaged) and 'Merusak' (Damaged). The table is currently empty.

**Figure 1.** The aspect NoS in Science Student Activity: science based on empirical evidence

Figure 2 shows a worksheet page with a section titled 'B. Zat Aditif Alami dan Buatan'. It includes a 'Liberal Sains' box with the text 'Menginterpretasikan Bukti dan Data Ilmiah'. Below this, there are two numbered questions with 'Jawab:' labels for answers.

**Figure 2.** Scientific literacy component "interpreting scientific data" insert in science student worksheet

Science Student Activities Sheet was tested limited on students of VIII D class of Junior High School N 2 Mlati students, amounting to 29 people. The field trials were conducted for three meetings with a total of 5 × 40-minute lessons. The scientific literacy test was given before (pretest) and after learning (post-test) through the implementation of NoS within inquiry-based learning approach. The result of the N-gain score from scientific literacy tested as Table 1 showed.

**Table 1.** The mean of scientific literacy test result and its N-gain score

No.	Scientific Literacy Component	Mean		N-gain Score	Category
		Pretest	Posttest		
1.	Explaining phenomenon scientifically	24.33	79.39	0.73	High
2.	Designing scientific investigation	33.44	84.78	0.77	High
3.	Evaluating scientific investigation	25.00	64.33	0.52	Medium
4.	Interpreting scientific proof and data	21.20	73.00	0.66	Medium
	Total	26.45	78.62	0.71	High

Table 1 showed that there was an improvement in students' scientific literacy by using science learning material based on NoS within inquiry learning approach. It was shown from N-gain score value which was 0.71 (high category). In general, all aspects of students' scientific literacy improved. There was an improvement in general of scientific literacy component. The result of the test of prototype Science, Student Activities Sheet, is synchronized with Bell (2009) state that teaching about the nature of science can increase student interest, as well as developing awareness of the impacts of science in society so it can develop student scientific literacy. The integration of explicit, reflective instruction about nature of science (NOS), and scientific inquiry (SI) in traditional science content is addressed as a means through which the development of scientific literacy is fostered [12]. By making the inquiry, the student can get basic experience to make a reflection of understanding about NoS. The inquiry is an approach to learning whereby students find and use a variety sources of information and ideas to increase their understanding of a problem, topic, or issue [14]. The teacher also must believe that teaching in through inquiry approach is not just transfer of knowledge, but it can make learning behavior changing, and it's important because the problems are more complicated and the situation more variation in the global era [15-17]. The combination of understanding NoS and inquiry approach in the science learning as an innovative approach can develop scientific literacy.

#### 4. Conclusion

Based on the result and discussion, we could conclude that science learning material prototype based on NoS within inquiry learning approach was considered to be very good, seen from the material, presentment, graphic, and language aspects by lecturer and teacher, and it was appropriate to be used in the learning process. The prototype of student worksheet based on NoS within inquiry learning approach could improve students' scientific literacy.

#### References

- [1] Permanasari A 2011 Pembelajaran sains: wahana potential Untuk membelajarkan softskill dan karakter. *Seminar Nasional Pendidikan MIPA UNILA (Lampung, Indonesia)*
- [2] Savitri M and Maryati A M 2015 Rekonstruksi bahan ajar bermuatan view of nature of science untuk pembelajaran IPA di SMP. *Simposium Nasional Inovasi dan Pembelajaran Sains 2015 UPI (Bandung, Indonesia)*
- [3] Allchin D 2013 *Teaching the nature of science. Perspectives and resources.* (St. Paul, Minnesota: SHiPS Education Press)
- [4] Ergul R, Yeter S, Sevgül Çalu, Zehra Özd Leku G and Meral A 2011 *Bulg. J. Sci. Educ. Policy* (BJSEP) **5**
- [5] Abd-El-Khalick F 2005 *Int. J. Sci. Educ.* **27** (1) 15-42
- [6] Lederman J S and Lederman N G 2011 *The development of scientific literacy: a function of the interactions and distinctions among subject matter, nature of science, scientific inquiry, and knowledge about scientific inquiry.* In C. R. Linder (Ed.), *Exploring the landscape of scientific literacy* (New York: Routledge) pp 127-159
- [7] Griffiths A K & Barry M 1991 *Res. Sci. Educ.* **21** 141-150
- [8] Lederman N G, Lederman J S and Antink A 2013 *Int. J. Educ. Math. Sci. Technol.* **1** (3), 138-147
- [9] DeBoer G E 2000 *J. Res. Sci. Teach.* **37** (6) 582-681
- [10] Abrams E, Southerland S A and Evans C A 2007 *Inquiry in the classroom: necessary components of a useful definition.* In E. Abrams S A, Southerland and Silva P (Eds.), *Inquiry in the science classroom: Realities and opportunities* (Connecticut: Information Age) pp. 11-13
- [11] Kuhlthau C C, Maniotes L K and Caspari A K 2007 *Guided inquiry (learning in The 21<sup>st</sup> century)* London: Libraries Unlimited
- [12] Lederman N G and Lederman J S 2004 *Sci. Teach.* **71** (9) 36-39
- [13] Abd-El-Khalick F and BouJaoude S 1997 *J. Res. Sci. Teach.* **34** (7) 673-699
- [14] Lederman N G 2006 *Asia-Pasific Forum Sci. Learn. Teach. J.* **7** (1) 1-11
- [15] Ochanji M 2008 *Calif. J. Sci. Educ.* **8** 83-106

- [16] Toharudin U and Hendrawati S 2011 *Membangun literasi sains peserta didik*. (Bandung: Humaniora)  
[17] Vieira M, Tenreiro-Vieira C and Martins IP 2011 *Sci. Educ. Int.* **22** (1) 43-54



# Applying innovative approach “Nature of Science (NoS) within inquiry” for developing scientific literacy in student worksheet

## ORIGINALITY REPORT

7%

SIMILARITY INDEX

6%

INTERNET SOURCES

6%

PUBLICATIONS

4%

STUDENT PAPERS

## PRIMARY SOURCES

1

[repository.ubaya.ac.id](https://repository.ubaya.ac.id)

Internet Source

2%

2

[dergipark.ulakbim.gov.tr](https://dergipark.ulakbim.gov.tr)

Internet Source

1%

3

[dspace.ewha.ac.kr](https://dspace.ewha.ac.kr)

Internet Source

1%

4

Renee M. Clary. "Can the history of geology inform geoscience education and public reception of climate change? Lessons from the history of glacial theory", *Geosphere*, 2018

Publication

1%

5

[files.eric.ed.gov](https://files.eric.ed.gov)

Internet Source

1%

6

[www.scribd.com](https://www.scribd.com)

Internet Source

1%

Exclude quotes Off

Exclude bibliography On

Exclude matches < 1%

# Applying innovative approach “Nature of Science (NoS) within inquiry” for developing scientific literacy in student worksheet

---

## GRADEMARK REPORT

---

FINAL GRADE

**/20**

GENERAL COMMENTS

**Instructor**

---

PAGE 1

---

PAGE 2

---

PAGE 3

---

PAGE 4

---

PAGE 5

---

PAGE 6

---

PAGE 7

---