

# Development Fun-Chem Learning Materials Integrated Socio-Science Issues to Increase Students Scientific Literacy

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**Abstract:** *Field study research showed that the students were not familiar with the type of questions issued by the PISA for scientific literacy aspects. This is thought to be one of causes of Indonesian students' scientific literacy level that had rank 64 out of 65 participating countries. The low scientific literacy teaching, because learning materials used have not contextual and relates in everyday life. This research to develop teaching materials that can be a bridge of gap between theory learned in school with everyday life. This study aims to determine the feasibility of Fun-Chem learning materials Integrated to socio-sciences to increase the scientific literacy of vocational school students. This research used Research and Development (R &D) procedures that consist of define, design, and develop stage. The technique to analyse data used descriptive and inferential statistical analysis. The result of the Fun-Chem learning materials fulfilled the criteria for a valid, effective and had a positive response from students, with the N-gain performance for scientific literacy competency is 0.68 (medium). This is because the characteristics of the Fun-Chem learning materials is made student happy, also linking the socio science issues to the chemistry subject material, especially redox material. The Fun-Chem learning materials were also completed with inquiry worksheets that helped students to construct a pattern in which the invention of the expected concept.*

**Keywords:** Scientific literacy, fun-chem learning materials, socio-sciences

## 1. Introduction

A challenge of the 21st century requires innovative thinking based on scientific thinking and scientific discovery. Society requires the generation that can create innovative new technologies that could be the basis to address the economic, social, and environmental. Education should produce a generation of science literacy that has a rationale and innovative scientific discovery to support Indonesia's competitiveness on the world stage, without forgetting the aspect of its social effects. Scientific literacy prepares responsible citizens and sensitive to the issues around their lives. This is because scientific literacy emphasis on decision-making on social issues if the terms of the scientific knowledge that has been obtained (socio - scientific issues) as well as solving the problem (Holbrook & Rannikmae , 2007) .

Scientific literacy emerged as a result of the challenges facing the greater global community related to the provision of adequate food and water, disease control, generating sufficient energy and adaptation to climate change (UNEP, 2012). Scientific literacy is a key competence in preparing a generation that is able to use knowledge and information science to interact with the challenges of life (OECD, 2013). Referring to this, the ownership of the local culture in Indonesia as an identity and the identity of a nation needs to be improved as a source of learning in science education. Science education that takes into account local cultural wisdom [ethnoscience] national identity, character and customs of the local culture is one thing to consider in the development of curriculum in 2013 at this time. The importance of building (reconstruction) scientific science-based knowledge culture or Ethnoscience, is because Indonesia has about 370 ethnic groups, of which the cultural

diversity has not been developed as a source of learning in science learning (Sudarmin, 2014). Dawson (2002) suggests a paradigm for science education today is based on culture and local wisdom, because it is in an effort to improve the scientific literacy of students.

Factor that was considered as one of the causes was the lack of scientific literacy teaching materials. Instructional materials used for students in learning at school have not been linking knowledge with students' social lives. Some teaching materials that refer to the old curriculum forced students to memorize the concept, and do not invite students to find meaning and relevance to their lives individually, society, and the state (Suharyadi, Permanasari, Hernani, 2013). The results of the study of the Word (2007) support this statement, textbooks that have so far more emphasis on the content dimension of the process and context dimensions as required by PISA, thus might cause low levels of scientific literacy Indonesian children. This is commensurate with the results of a field study conducted by researchers. This is much different from the conditions of the country's first rating is Shanghai with the acquisition of the average score is 580 scientific literacy.

The phenomenon that shows Indonesian students scientific literacy is low, for example: when the rain is full of lightning, they usually feel safe to shelter under a tree, or a story of someone who brought firecrackers wrapped tightly in a bus on a very hot weather, then resulting a fire (Liliasari, 2011). After students getting out of school, they will be citizens with a wide decision of life they should take. For example, as citizens, students are free to choose to live in the consumptive attitude, wasteful of energy, throwing garbage in the river, and all other living options that can be retrieved instantly. If it is passed, then the natural resources that we

have now will not be sustainability. This is because citizens are formed from individuals who are less "science literacy" "to become irresponsible citizens (not to think about the continuing impact of their activity). Students who have scientific literacy are trained to explain natural phenomena scientifically, so that students are accustomed to make observations, investigations, taking into account other aspects besides him. Students will be wise in making decisions, because students do not immediately make a decision without an investigation (although for small things like taking out the trash problem. (Fibonacci, Sudarmin, Haryani, 2013)

The results have implications for scientific literacy low student lack of knowledge of chemistry. The low level of chemistry literacy in students learning process is affected by unattractive and irrelevant the daily lives of students, not contextual, and does not lead to better cognitive skills high. Brist (2012:1) states the current trend of chemistry learning does not imply increased literacy chemistry, because chemistry students who study tend to be bombarded with chemical formulas that had no connection with real life and environment of students, regardless of the culture, so they tend to memorize, and then easily dispose of without a trace. Efforts to improve scientific literacy can be done in various ways and learning activities. One way to do is to use scientific texts (Yarden, 2009). The content of instructional materials is integrated with social issues (socio-sciences) to make it more relevant to students' lives. This is based on study Marks & Eilks (2009), which implements the problem-oriented models using the socio-sciences learning in order to improve the scientific literacy of students in Germany. Blonder (2008) tried to improve the scientific literacy of students with the use of the parcel module that has been proven to improve scientific literacy. The results of the study Souza and Porto (2012) indicates that the module is relevant to students' lives can improve the scientific literacy of students.

A development of teaching materials is done by taking into account the characteristics of the students and refers existing teaching materials and is owned students. Thus a prepared teaching material requires students to read and understand before learning in the classroom. A characteristic of teaching materials developed is a fun instructional material through image berakitan science issues, using social issues-related scientific everyday life, with the hope of improving the scientific literacy of students. Conolly (2002) and revealed that through a module, we can change the traditional curriculum, for example, studied the stoichiometry and mole equation with the theme "Do You Contribute To Greenhouse Gas Emissions? Stoichiometric "would be more interesting than directly asking the students to learn the content of the stoichiometry and the mole. From these themes, students will use laboratory investigations and stoichiometric calculations to determine whether we personally contribute to greenhouse gas emissions. The purpose of this study was to determine: (a) the validity of the teaching materials Fun-Chem integrated socio-sciences that have been developed; (b) the effectiveness of instructional materials Fun-Chem integrated socio-sciences are developed and applied through guided inquiry on the attainment of scientific literacy; (c) students'

response to instructional materials Fun-Chem integrated socio-sciences are applied through guided inquiry.

## 2. Method

This research is an educational research and development [R & D] modification of Four D which includes the stages Define, Design, Development, and Desimination (Trianto, 2009) were performed to produce an integrated socio fun-Chem instructional materials science. Development is done through three stages: define; design, and development, stage dessimination not done because of time considerations and implementation as well as the consideration that reached the stage of develops tools has produced a good (valid).

Define phase aims to establish and define learning needs by analyzing the process and outcomes of student learning, scientific literacy and competence matter oxidation-reduction reactions. Stage design is to design a learning device consisting of syllabi, lesson plans, modules, student worksheets, and evaluation tools of learning, so that the resulting shape of the design of integrated learning fun-Chem sasio-science. While on stage includes validation experts develop, test a small, a large trial and test the feasibility of the product development of teaching materials Fun-Chem integrated socio-science for use in the teaching and learning process in the classroom-based guided inquiry. The subjects were students of class X SMK NU Ungaran. The type of data in this study included qualitative and quantitative data, measured by using the research instruments. Instruments used in the study were test and non-test instrument. Data analysis techniques include qualitative and quantitative techniques depending on the type of data used.

Indicator of the success of the study are: (a) instructional materials Fun-Chem integrated socio-sciences have developed moderate level of validity; (b) the average of the test results in the classical scientific literacy competencies meet  $\geq 70$  and the proportion of classical learning mastery is achieved if 30 of the 40 students achieving at least 70; (c) instructional materials Fun-Chem integrated socio-sciences are applied through guided inquiry developed getting a positive response from students; (d) an increase in scientific literacy competence after learning conducted with instructional materials Fun-Chem integrated socio-sciences are applied through guided inquiry as indicated by an average of at least N-gain performance at a moderate level.

## 3. Result and Discussion

### 3.1 Description of Preliminary Results

The Average Indonesian students on the PISA test is still at level 1. At this level, students can only suggest a suitable source of information on the topic of science. Students can identify the quantity that occurs in an experiment. For a specific context, students can only identify whether a variable can be measured or not (Bybee, McCree, Lawrie, 2009). So it's important to increase the scientific literacy level of Indonesian students, and must be begin by each person of the teacher. So, researcher begins to research the SMK NU Ungaran Semarang. The study begins informally observe the characteristics of schools, teachers, students and the learning process. These activities are guided by a chemistry teacher at

SMK NU Ungaran. Observations and interviews with teachers and students shows that students tend not to pay attention when the teacher explains the material. Interaction is also still impressed one direction, only the teacher to the student. It shows that the students' interest towards learning chemistry is still relatively low. The data confirmed the results of the field study questionnaire distributed to student's researchers, 32 of the 40 students stated that chemistry is a difficult subject to understand. This is consistent with the results of the study Sirhan (2007) and Talanquer (2011) Students have difficulty understanding the material chemistry, because chemistry related macroscopic concepts, submikroskopis, and symbolic. This was confirmed by the results of the questionnaire field study which showed that 31 of the 40 students stated that there was no relationship with the chemical social issues that exist in the environment around the student. This means that students cannot connect the macroscopic level, microscopic, and submikroskopis as revealed by Johnstone (2000).

Preliminary research began the last week of November 2013 to January 2014. Preliminary research activities include observation, interviews and document research to identify problems and learning needs in the School of Chemistry. Observations and informal interviews indicate that the need for teaching materials and reference chemical Fun-Chem important curriculum provided to students in 2013, this is due to the curriculum in 2013, teachers were not allowed to sell traded Student Worksheet (SW). The results of the analysis of questionnaire data indicates that students need a fun teaching materials that can be read in advance, so that students come to school already has sufficient knowledge of the house. Results of analysis of questionnaire data indicates that students are not familiar with the type of chemistry integrates social issues such as those used in the PISA tests.

### 3.2 The Result of the Fun-Chem Learning Materials Integrated Socio-Science

The definition of scientific literacy in PISA 2015 is the capacity to use scientific knowledge, procedural knowledge, and epistemic knowledge to identify questions, describe an evidence based conclusions in order to understand and help make decisions about the nature and changes to it through human activity. Three competencies required of a person under the framework of science literacy PISA 2015 can be seen in Table 1.

**Table 1:** Science Literacy Competency

No.	Competence	indicator
1.	Explaining of phenomena scientifically	Acknowledging, offer and evaluate explanations for natural phenomena and technology.
2.	Evaluating and Designing a Scientific Investigation	Explaining and assessing scientific inquiry and propose ways of addressing scientific questions.
3.	Interpreting data and scientific evidence	Interpreting data and scientific evidence Analyzing and evaluating scientific data, claims and provide arguments in a variety of presentation and draw appropriate conclusions

(Reference : OECD, 2013)

The Characteristics of Fun-Chem teaching materials are fun and integrated of social-scientific issues. Fun instructional materials were designed based on the findings of the current study filed that showed the involvement of students in learning chemistry is still relatively low (low student interest). According to the findings of Spiegel, McQuilan, Halpin, Matuk, Diamond (2013) young people will be engaged in learning science by using comics and illustrated stories. Based on these findings, researchers used a comic strip in Fun-Chem teaching materials in order to be able to increase the involvement of students, especially in science learning adolescence. The interview result also showed that students were interested in the redox material, because in the opening of learning activity it was presented by using comic strip.

The device used in the study of learning, geared to reach the third scientific literacy competencies as listed in Table 1. Wei, B & Thomas, G.P. (2006) found that the use of social science issues in learning can improve the scientific literacy of students, therefore, this study instructional materials Fun-Chem besides designed with fun features, contains comic chemistry, redox song joss, also uses social-scientific issues. MacFarlane (2001) said that learning log can be used as a tool to help students construct their knowledge, so FunChem learning material is also completed with learning log. Devices tested before learning to students, validated by experts materials and media experts to determine the feasibility of product development in this study. Validation by expert panel material done by experts. From the results of this expert assessment, then calculate the validity of teaching materials Fun-Chem as summarized in Table 2.

**Table 2:** Results Scores Matter Expert Assessment of Teaching Material Fun-Chem

Aspect	Validator Score	Criteria
Feasibility of Contents	0,97	Valid
Presentation components	0,96	Valid
Linguistic components	0,94	Valid
Characteristics of Social-sciences Insight Module	0,95	Valid
Results Overall aspects	0,96	Valid

The average score of Validator obtained from the whole aspect was 0.96 that is categorized as valid, based on the formula of Aiken, so it can be said that Fun-Chem teaching materials developed by researchers can be used in learning activity, though it still needed some revisions. Assessment rubric for Fun-Chem instructional materials was designed by referring to the assessment of curriculum text books issued in 2013 by the National Education Standards and Puskurbuk. Material experts will assess the feasibility aspect of the content, the presentation component, linguistic components, and characteristics component of socio-minded science teaching materials, while media experts assessed the graphical aspects.

### 3.3 The Increasing of Literacy Science of Students

Test the effectiveness of the product development of scientific literacy competencies students conducted research on the subject is class X SMK NU Ungaran total 40 students with research design one group pre-test post-test design. The

instrument used to measure the competence of scientific literacy is shaped test item description that integrates scientific literacy competencies (refer to the PISA 2015 assessment framework) with a basis for subject matter competence redox.

Before treated, the students were given a pre-test about the competence of scientific literacy (which is integrated with the concept of redox mastery tests) and asked to complete a questionnaire of attitude toward science. After the pre-test, students were given a treatment of guided inquiry learning with Fun-Chem instructional materials integrated Socio-sciences. In the last meeting, students were given a post-test about the competence of scientific literacy (which is integrated with the concept of redox mastery tests) and asked to complete the questionnaire attitude toward science to see the increasing of scientific literacy competence, and attitude toward science improvement.

Data analysis that was used to see the difference of scientific literacy competency test results (which is integrated with a redox concept mastery test), was performed by using paired samples t-test. Paired samples t-test required a few prerequisites that the data pre-test and post-test should be normally distributed. Therefore, prior to testing the hypothesis, then testing the normality of the data pre-test and post-test using the program SPSS 17.0 Kolmogorov Smirnov and test showed that the data sig > 0.05, it meant that the data of pretest and post-test was normally distributed. Average data of pre-test and post-test are presented in Table 3.

**Table 3:** Results of Pre-Test and Post-Test Science Literacy Competency

Data	Significance	Normality of Data
Pre-test	0,084	Normal
Post-test	0,097	Normal

Pre-test results of all 40 students did not reach the minimum criteria KKM (70), while based on the results of the post-test, it was found that out of 40 students 35 of them reach the KKM (> 70). Other results can be seen from the average value in the classical style, where an increase in the average value of scientific literacy competency test (which is integrated with a redox concept mastery test) after a given treatment, that is, from the previous 31 to 78. Speaking about the thoroughness of the student, then the condition post-treatment showed increased than before treatment. When pre-treatment, the number of students who did not complete is 40 students, while the post-treatment condition only 5 students who did not complete.

The data in Table 3 showed that the significance of the data pre-test and post-test > 0.05 so that it can be concluded that the data were normally distributed. Because the data of pre-test and post-test is normal, the paired samples t-test could be performed. Data on improving the competence of scientific literacy was calculated by using the value of N-Gain. The results of the analysis of N-Gain Class X result in the average achievement level of 0.68 and into the category of being. Of the 40 students, students who achieve high N-Gain of 15 and 25 other students were in the middle category. Post-test results showed that 35 students achieved score > 70,

with an average in the classical 78 which means that the implementation of teaching materials through guided inquiry Fun-Chem was effective in improving scientific literacy competence. The use of social issues in the teaching materials Fun-Chem turns equally effective in improving the competence aspect of scientific literacy. Similar findings were obtained from the research Barab, Sadler, Heiselt, Hickey & Zuiker (2010) that the use of socio-scientific issues can provoke inquiry skills, so as to increase the scientific literacy of students.

**Table 4:** The mean scores pre-test, post-test and N-Gain Literacy Aspects of Competence in Student Ability Group High, Medium and Low

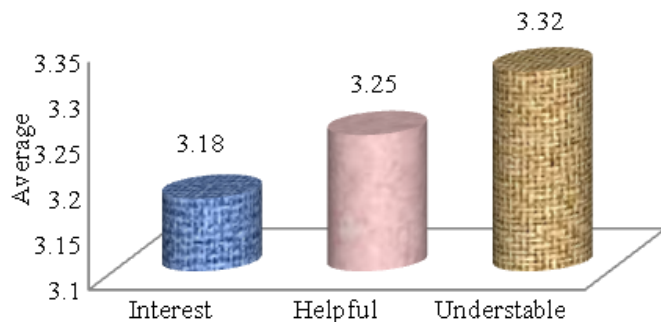
Group	$\bar{X}$ Pre-Test	$\bar{X}$ Post-Test	$\bar{X}$ N-Gain	Criteria
High-ranking	43	82	0,69	moderate
Moderate-ranking	30	79	0,70	higher
Low-ranking	20	72	0,65	moderate

The resulting increase in competence aspects and aspects of students' attitudes toward science had shown the same pattern when viewed by a group of high ability, medium and low. This is associated with students' attitudes toward research science. It can be seen from Table 4:14 that shows the highest increase in the profile scientific literacy aspects of students' attitudes toward science achieved by a group of students capable of being, which is then followed by a group of high-ability students and the last is on the low-ability students. Similar findings resulted from research of Prokop, Tuncer, and Chuda (2007) who conducted a study of 655 students Slovakia to see the impact of students' attitudes toward science (attitude toward science) to the achievement of science students' learning outcomes.

Results of classroom observations indicate that the low group students tend to be difficult to set up, it is suspected to be the reason why the increase in N-Gain Low also small groups. If the group was experiencing an increase of N-Gain is greatest, this is presumably because the group was happy and tend to show a high interest for learning, actively asking. This study was also intended to see how the students' response to learning using teaching materials Socio-minded Fun-Chem applied sciences through guided inquiry. To determine the students' response to learning using teaching materials Socio-minded Fun-Chem applied sciences through guided inquiry, researchers used a questionnaire which is reinforced by the interview after filling the questionnaire. Questionnaire to determine students' responses to a text resource questionnaire consisted of three indicators described in 20 of the questions. The questionnaire is based on a modification of the questionnaire developed by Tasdelen & Koseaglu (2008) on the text in the learning teaching materials.

### 3.4 Students' Response

The results of the analysis of the student's response obtained a score of 2593 which is in the category of accepting the instructional materials of Socio-minded Fun-Chem applied sciences through guided inquiry. If the indicators are grouped based questionnaire, students' response to the profile of teaching materials Fun-Chem can be seen in Figure 1.



**Figure 1:** Student response profile of subjects fun-chem

Fun-Chem Instructional materials integrated social-sciences were considered as attractive, easy to understand, and assist students in learning the redox with the 2593 acquisition of scores in the category agreed. This is commensurate with the opinion of Tasdelen & Koseaglu (2008) which says a text teaching materials said to be good, if it gets a positive response of the students related aspects of the attractiveness of the (interesting), the extent to which can help students (helpful), and how the ease to understand by students (understandable).

#### 4. Conclusion

Based on the results of the study can be summarized as follows: a) the results of the validation of integrated teaching material Fun-Chem socio-material sciences redox chemistry that was developed to obtain a valid criterion to validate the value of 0.96 for use in learning chemistry; b) the application of instructional materials sciences Fun-Chem integrated socio-effectively meet the criteria. It is shown the average results of tests of competence in the classical scientific literacy is 78 (score > 70) and the classical mastery learning which students completed 35 of 40 students (KKM above 70); c) students 'response to the implementation of teaching materials Fun-Chem integrated socio-sciences received a positive response, d) integrated Fun-Chem teaching materials developed socio-sciences can improve aspects of scientific literacy in the achievement of competencies with a mean N-gain is 0.68 and the aspect of students' attitudes toward science and the achievement of the N-gain 0.16.

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