Guided Inquiry with Cognitive Conflict Strategy: Drilling Indonesian High School Students’ Creative Thinking Skills

A F Syadzili¹, Soetjipto², Tukiran³

¹Science Education Study Program, Graduate Program, Universitas Negeri Surabaya, Surabaya 60231, Indonesia
²Department of Physics, Universitas Negeri Surabaya, Surabaya 60231, Indonesia
³Department of Chemistry, Universitas Negeri Surabaya, Surabaya 60231, Indonesia

Abstract. This research aims to produce physics learning materials in Indonesian high school using guided inquiry with cognitive conflict strategy to drill students’ creative thinking skills in a static fluid learning. This development research used 4D model with one group pre-test and post-test design implemented in the eleventh grade students in the second semester of 2016/2017 academic year. The data were collected by validation sheets, questionnaires, tests and observations, while data analysis techniques is descriptive quantitative analysis. This research obtained several findings, they are: the learning material developed had an average validity score with very valid category. The lesson plan can be implemented very well. The students’ responses toward the learning process were very positive with the students’ interest to follow the learning. Creative thinking skills of student before the implementation of product was inadequate, then it is very creative after product was implemented. The impacts of the research suggest that guided inquiry may stimulate the students to think creatively.

1. Introduction

Teachers are the first factor that determine the success of learning. According to the 2013 curriculum, it is necessary that the competence of educators and education personnel should be in conformity with the curriculum and textbooks [1]. The teachers’ preparation become very important because teachers will carry out a mandate of learning that aims to encourage students to be better in doing observations, making questions, reasoning, and communicating what they gain or they know after receiving the learning material [2].

Learning materials have an important role in learning, which can help teaching and learning activities become more effective, and it is expected that students can be drilled to think creatively. Because creative thinking is very important for the students to be drilled in order to find out knowledge by themselves. Learning teachers should prepare the students to have the ability to solve problems, to be critical, and to be creative, with national, regional, and global insight [3].

The use of learning material that emphasizes on the the five points of learning experience aims to prepare the students to cope with the 21st century, learning materials should accommodate diverse skills, such as creative thinking skills. Thinking creative could be identified by four aspects, namely fluency, flexibility, originality and elaboration [4]. In this regard, creative thinking involves the ability to produce original ideas, to feel new relationship and not suspected, or to build a unique and
good sequence between seemingly unrelated factors [5]. Creativity is what happens when an individual produces something that is novel as well as appropriate, generative or influential [6].

The most important objective of the creativity test is to identify the creative potential of a child (students). Creativity test is a test to measure divergent thinking skills. Creativity is very important and meaningful in life as its provisions when living in society, nation and state. Creative potential can be measured through several approaches, namely direct measurement; indirect measurement; measuring creativity elements; measuring the characteristics of creative personality; measuring creative potentials in a non-test manner, and assess real creative products [7]. Learning at school should be shifted from being told to be searching actively, and therefore students must be equipped with creative thinking skills.

The results of observation conducted at MA Negeri Lumajang as the Islamic state high school showed that the learning material has not implemented the mandatory of curriculum 2013. The learning process which is reflected in the lesson plan, the students were not taught to do activity observing, asking questions, collecting information, associating, and communicating and the learning is not reflected the activities that involved the students to think creatively, and the learning activities were still dominated by teachers, so that it was observable that the learning activities did not involve the students to do creative thinking. The other facts obtained were that based on the results of the creative thinking tests which were given out and filled out by 12 students, found that the average of students’ creative thinking was as much as 40.62% with less creative category. This percentage indicated that the students in the school still had a very low creative thinking skill.

Based on the phenomenon, teachers must posses the principles of learning, the use of instructional media, textbooks, student worksheets, as well as selecting and using learning models [8]. One of the learning models that can stimulate students’ active involvement in the learning process is by using guided inquiry learning with cognitive conflict strategy. Guided inquiry can help students to practice in a team, develop competencies in research, knowledge, motivation, writing skills, cooperative learning and social skills [9]. Guided inquiry can also help children in creative thinking. Through creative thinking, students are able to solve problems of everyday life. In line with this issue, guided inquiry learning is constructed with the aim of improving the students’ concept understanding and scientific performance [10].

The solutions to reduce the problems and the results of the observations above were to convey anomaly information to create a cognitive conflict in students’ mind, of course, by taking into account the students’ prior knowledge. The students’ prior knowledge is very important to facilitate and link the knowledge that students already have with the knowledge they will receive. Cognitive conflict is a perceptual state in which one notices the discrepancy between one’s cognitive structure and the environment (external information), or among the different components (e.g., the conceptions, beliefs, substructures and so on) of one’s cognitive structure [11]. Cognitive Conflict generates disequilibrium state which means lack of mental balance. Understanding someone of information, idea, or concept that is plagued by information is considered as contradictory [12]. Cognitive conflict consists of conflicts between conceptions in cognitive structures. The cognitive structure means the structure of knowledge organized in the brain. Conceptions mean a mental representation or a concept understanding in a cognitive structure [13]. The cognitive conflicts presented by teachers are expected to make the students aware of the initial misconceptions. The students would experience a conflict with anomalous phenomena, so that the students would feel challenged to think and question why their initial thinking was wrong. This process will eventually reconstruct the students’ concepts to be the correct concepts.

The phases of guided inquiry learning with cognitive conflict strategy adapted as follows: the planning phase with cognitive conflict strategy, retrieving phase (obtaining information with cognitive conflict strategy), processing phase (processing information), creating phase (creating information), sharing Phase (communicating information), and evaluating phase [14]. Those are based on the explanation of guided inquiry, cognitive conflict strategy, and creative thinking skills above. The development of the learning material using guided inquiry with cognitive conflict strategy is expected
to be feasible (valid, practical, and effective) to drill the creative thinking skills of Indonesian high school students of physics learning. A good learning material at least have three important framework, those are validity, practicality and effectiveness [15].

2. Method
This research is a development research which aims to produce learning material including: syllabus, lesson plan, students’ text books, student worksheet, and tests of creative thinking skills, by using guided inquiry with cognitive conflict strategy on the static fluid learning material. The development of the learning material was refering to the Four D Models which consists of four stages, namely define, design, develop and disseminate [16]. This research only used three stages, namely defining, designing, and developing. The design of research used one-group pretest-posttest design. Pretest aims to determine the knowledge of early students before treatment by guided inquiry learning with cognitive conflict strategy, while posttest aims to determine the knowledge of students after treatment by guided inquiry learning with cognitive conflict strategy.

The subject in this research was learning material of physics in Indonesian high school using guided inquiry with cognitive conflict strategy to drill the students’ creative thinking skill which was developed by the researcher, and the subjects of the try-out were the eleventh grade students of MA Negeri Lumajang in the second semester of 2016/2017 academic year as many as 24 students. The variables in this research were: (1) the validity of the learning materials, which include syllabus, lesson plan, students’ textbooks, student worksheets, and creative thinking skill test; (2) the practicality of the learning materials, which include the completion of the lesson plan, and students’ activities; and (3) the effectiveness of the learning materials refering to the results of creative thinking skill test, and the students' responses toward the learning using guided inquiry with cognitive conflict strategy. The data collection was carried out by using validation, observation, testing, and questionnaires. The research instruments were developed based on the instruments of previous researchers which were adapted to the researcher’s needs, and the instruments were validated by experts to obtain input and suggestions before the instruments were used. The data were analyzed using descriptive quantitative analysis by analyzing the validity of learning materials, the data of the results of practicality and data of the results of the effectiveness.

3. Results and discussion

3.1. Validation of the learning materials
The results of validation analysis which were assessed by 3 expert validators, showed that the average validation score of the developed learning material was catagorized as very valid. If the validation score is ≥ 2.6, the learning material can be used with little revision [17]. The table 1 shows the analysis of the validation results of the developed learning materials.

| Device name          | Validation score | Average | Category   |
|----------------------|------------------|---------|------------|
|                      | 1st Validator    | 2nd Validator | 3rd Validator | |
| Syllabus             | 4.00             | 4.00    | 3.44       | 3.81 | Very valid |
| Lesson plan          | 4.00             | 3.89    | 3.28       | 3.72 | Very valid |
| Student worksheet    | 3.90             | 3.71    | 3.29       | 3.63 | Very valid |
| Student textbook     | 3.85             | 3.65    | 3.25       | 3.58 | Very valid |
| Creative thinking test| 3.69            | 3.62    | 3.69       | 3.67 | Very valid |
|                      | Average          | 3.68    |            |     |

3.2. The data of the results of practicality
3.2.1. The analysis of the completion of the lesson plan. The completion of the implementation of the learning material was observed by two observers for three meetings. The results showed that all the stages in the lesson plan in the try out was completed, and on the average scores of the completion of
the lesson plan 1, lesson plan 2, and lesson plan 3 were 3.61; 3.64; and 3.61 respectively with very good category. The instruments of the completion of lesson plan 1, lesson plan 2, and lesson plan 3 which were observed by two observers had average percentage of agreement of 97.02%, 98.04% and 97.02%. The developed instruments can be used if the percentage of agreement is ≥ 75% [18]. This means that all the steps of the learning process which were arranged in the lesson plans could be well implemented by the teacher, and in their assessment, the two observers gave relatively similar scores. The result of the lesson plans implementation analysis is provided in table 2.

| Lesson plan | Observers’ score | Average | Category | Percentage of agreement score |
|-------------|------------------|---------|----------|-------------------------------|
|             | 1st Observer | 2nd Observer |         |                               |
| 1           | 3.50            | 3.71 | 3.61 | Very good | 97.02% |
| 2           | 3.57            | 3.71 | 3.64 | Very good | 98.04% |
| 3           | 3.71            | 3.50 | 3.61 | Very good | 97.02% |

The outline of the lesson plan developed mainly consists of three activities. The three stages were organized based on the syntax of guided inquiry with cognitive conflict strategy. Learning activity I (introduction) contained mainly on the phase of planning with cognitive conflict strategy. In general, it was about apperception and preparing students to receive learning. Apperception was carried out by providing a phenomenon to generate cognitive conflict in students and asked students to practice their questioning skills by formulating various types of research problems of the given phenomenon. Teachers should provide a confusing situation to trigger the students’ curiosity and to motivate investigations [19]. In learning activity II (main activity), there are four steps or phases of guided inquiry with cognitive conflict strategy namely: (1) retrieving phase (gathering information with cognitive conflict strategy), (2) processing phase (processing information), (3) creating phase (creating information), and (4) sharing phase (communicating information). This stage encourages the students to drill their skills in gathering information, expressing ideas they have, and solving problems provided by teachers or problems which come from reading passage or from direct observation by students. In learning activity III (closing) there is one step or phase of guided inquiry with cognitive conflict strategy, namely the evaluating phase. This activity is mainly related to the role of teachers in assisting the students to conclude the results of the learning process, in case of conveying the findings that they got during the learning process, and the teacher gave evaluation test in the form of creative thinking skill test.

3.2.2. Analysis of students’ activity. Based on the results of the observation of the students’ activities, the students’ activities can be determined from the first meeting until the third meeting. This was proven from the average score of 24 students in the first meeting as much as 42.87; the second meeting 67.31; and the third meeting 68.12; and of the total score of 72. This means that the students’ activity have a significant increase. It shows that the students’ active involvement in the learning process makes them drille to find other alternatives in solving problems found in learning. Intelligence develops because people face new and confusing experiences, and then they try to resolve differences by linking the new knowledge with their prior knowledge and build new meaning [19]. The percentage of agreement average at the first meeting was 96.87%, at the second meeting was 98.75%, and at the third meeting was 98.63%. The instruments that had been developed could only be used when the percentage of agreement was about ≥ 75% [18].

3.3. Data of the results of the effectiveness
3.3.1. Description of students’ creative thinking. The instruments used to measure the students’ creative thinking skills is creative thinking tests. The test items were open-ended questions, that is a type of questions which has many possible correct answers. The open-ended questions can help improve creativity by producing diverse ideas, and students can solve their own problems in the future [20]. The creative thinking skills measured were fluency, flexibility, originality and elaboration.
creative thinking test was given to the students before the learning material was tried out as the pretest, and after the learning material had been tried out as the posttest.

The pre-test and the post-test of creative thinking skills were then analyzed to obtain the increased value (N- gain) of students’ creative thinking skills. The results of the analysis of the average increase of the students’ creative thinking skills after the three meetings learning process found that the gained score of the creative thinking was 0.79 with high category. If the gain score was $> 0.70$, then it was categorized as high gain score [21]. The results of the analysis indicated by the gained score showed an increasing case in students’ creative thinking skills with high category, with an average of the pretest 29.43 with less creative category, and with an average of the posttest 85.55 with very creative category. This accretion was certainly due to the implementation of guided inquiry learning with cognitive conflict strategy which was capable of drilling the students’ creative thinking skills. Guided inquiry also helps students to think creatively. Because of creative thinking, the students are able to solve problems in their everyday life [9].

3.3.2. Students’ responses toward the implementation of guided inquiry learning with cognitive conflict strategy. By the end of the learning process, after the three meetings of the learning process, the students were given a questionnaire about the learning activities. It proposed to the students’ responses toward the learning model and the learning material that had been developed. The results of analysis of the students’ responses toward the guided inquiry learning with cognitive conflict strategy and the learning materials developed. The results of the questionnaire showed that 23 of 24 students responded positively (feel interested, easy, and happy) toward the learning environment and 4% of the students still found some difficulties following the learning activities using guided inquiry with cognitive conflict strategy.

4. Conclusion
Based on the findings of the research and the analysis of the research findings, it can be concluded that the learning material of physics using guided inquiry with cognitive conflict strategy which had been developed is decent (valid, practical, and effective) to drill the students’ creative thinking skills. The impact of the research can be strongly said that the strategy can possibly stimulate the students to think creatively.

5. Acknowledgements
The author would like to give a special gratitude to the advisors. Because of their effort this article can be finished.

6. References
[1] Peraturan Pemerintah Republik Indonesia Nomor 32 Tahun 2013 tentang Perubahan atas Peraturan Pemerintah Nomor 19 Tahun 2005 tentang Standar Nasional Pendidikan 2013. Jakarta
[2] Permendikbud Nomor 81A Tahun 2013 tentang Implementasi Kurikulum. Jakarta: BSNP
[3] Wardani L K 2003 Berpikir kritis kreatif (sebuah model pendidikan di bidang desain interior) http://digilib.petra.ac.id pp 97-111
[4] Torrance E P and Ball O E 1984 The Torrance Tests of Creative Thinking Streamlined (revised) Manual, Figural A and B (Bensenville, IL: Scholastic Testing Service Inc)
[5] Filsaime D K 2008 Menguak Rahasia Berpikir Kritis dan Kreatif (Jakarta: Prestasi Pustaka) p 8
[6] Zhanetta G 2011 Unraveling the Mystery Behind Creativity E-joernal The Journal of Effective Teaching 3(2) pp 234-246
[7] Munandar U 2009 Pengembangan Kreativitas Anak Berbakat (Jakarta: Rineka Cipta)
[8] Mulyasa E 2013 Pengembangan dan Implementasi Kurikulum 2013 (Bandung: Remaja Rosdakarya)
[9] Kuhlthau C, Maniotes L K and Caspari A K 2007 Guided Inquiry: Learning in the 21st Century (USA: Libraries Unlimited. Inc) pp 1-4

[10] Dewi K, Sadia I W and Ristiai N P 2013 Pengembangan Perangkat Pembelajaran IPA Terpadu dengan Setting Inkuiri Terbimbing untuk Meningkatkan Pemahaman Konsep dan Kinerja Ilmiah E-Journal Program Pascasarjana Universitas Pendidikan Ganesha 3 pp 20-21

[11] Lee G, Kwon J, Sang-suk P and Jung-whan K 2003 Development of An instrument for Measuring Cognitive Conflict in Secondary-Level Science Classes Research in Science Teaching 40(6) pp 585-603

[12] Sela H and Zaslavsky 2007 Resolving cognitive conflict with peers- there is different between two and four? Proceeding of the 31st Conference of The International Group for The Psychology of Mathematics Education Seoul-PME 4 pp 169-176

[13] Kwon J and Lee G 2001 What Do You Know about Students Cognitive Conflict: A Theoretical Model of Cognitive Conflict Process Proc. of 2001 AETS Annual Meeting Costa Mesa CA pp 309-325

[14] Branch J and Oberg D 2004 Focus on Inquiry A Teacher Guide to Implementing Inquiry Based Learning (Canada: Alberta Education) pp 45-74

[15] Nieveen N 1999 Prototyping to Reach Product Quality: Design Approaches and Tools in Education and Training (Netherlands: Kluwer Academic Publishers) pp 125-136

[16] Thiagarajan S, Semmel D S and Semmel M I 1974 Instructional Development for Training Teacher of Exceptional Children a Sourcebook (Bloomington: Center for Innovation on Teaching the Handicapped ) p 3

[17] Ratumanan T G and Laurens T 2015 Penilaian Hasil Belajar pada Tingkat Satuan Pendidikan 3rd Edition (Yogyakarta: Pensil Komunika) p 181

[18] Borich G D 1994 Observation Skill for Effective Teaching (New York: Macmillan Publising Company) p 385

[19] Arends R I 2012 Learning to Teach 9th Edition (New York: McGraw-Hill) pp 394-462

[20] Sternberg R J 2012 The Assessment of Creativity: An Investment-Based Approach Creativity Research Journal 24(1) pp 3–12

[21] Hake R R 1998 Interactive-Engagement Versus Traditional Methods: A Six-Thousand-Student Survey of Mechanics Test Data for Introductory Physics Courses American Journal of Physics 66(1) pp 64-74