JPII 7 (1) (2018) 16-24

Jurnal Pendidikan IPA Indonesia

http://journal.unnes.ac.id/index.php/jpii

DEVELOPMENT OF DIGITAL STORYTELLING-BASED SCIENCE TEACHING MATERIALS TO IMPROVE STUDENTS' METACOGNITIVE ABILITY

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DOI: 10.15294/jpii.v7i1.12718

Accepted: January 15th, 2018. Approved: February 15th, 2018. Published: March 19th, 2018

ABSTRACT

This study aims to produce digital-based storytelling teaching materials of natural science that can facilitate the students to be able to explore the object of science learning deeply and to improve their metacognitive ability. This research is development research. The samples used are four teachers and 40 junior high school students. The technique of gathering data employed a testing method, documentation study, and questionnaire. Validation is done to determine the feasibility of teaching materials. The research result of the improvement of students' metacognitive ability is measured by using the testing method in the form of pretest and posttest. Pretest and posttest data were analyzed by N-gain and t-test of significance. The result of the research shows that the average percentage of validation result of media expert and material expert is 97,70% and 95,16%. According to experts, all developed products are very feasible to use. The results of metacognitive enhancement (N-gain) for levels 1 to 5 respectively were 0.36; 0.56; 0.49; 0.45 and 0.39. The results of significance test showed that the t-count 7.65 and t-table of 2.03 which that the mean improvement of the metacognitive ability of students is significant. Based on the results of this study, it can be concluded that the teaching materials based on digital storytelling are feasible to be used to improve students' metacognitive ability.

Keywords: teaching materials of natural science, metacognitive, digital storytelling

INTRODUCTION

Curriculum 2013 requires the integration of one field of science with other fields of science. This integration should also be presented in the subject of natural science. Based on the 2013 curriculum, natural science subject at the junior level should be developed as integrative science subjects, not as disciplinary education. It means that the deliveries of material concepts from various disciplines are presented in an integrated way and not in the separated way (Sholihat, 2015). The use of varied media is needed in the science lesson. This is because the varied learning media can develop students' motivation in learning (Ali, 2009).

Metacognitive competence is ability or mental activity in cognitive structure done by an individual to set up, control, and check his thinking process (Haryani, 2012). Metacognitive

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competence needs to be developed and improved towards students' to improve their high-level skill which will lead to increase education quality (Sumampouw, 2011). The five aspects in metacognitive competence which need to be cultivated to students are: awareness of thinking process and ability to develop it, developing the introduction of thinking strategies, evaluative procedural reflection, transferring knowledge and procedural experiences to other contexts, linking conceptual understanding with procedural experience (McGragor, 2007; Anderson, 2001).

Flavell states that students' (even people in general) metacognition demands to be developed for the following reasons: (1) students should have a tendency to think a lot, in other words, the more metacognition, the more cognition is needed; (2) students' thought tend to be wrong, thus, good monitoring and arrangement are essential; (3) students should be willing to communicate, explain, and give clear reasons for their thoughts to others and themselves, this activity surely requires cognition; (4) in order to survive and be successful, students have to plan their future and critically evaluate other probable plans; (5) if students are in need of making tough decision, metacognitive skills are demanded; (6) students should have a necessity to infer and tell their psychological event to themselves and others. This tendency to engage in metacognitive activity indicates social cognition (Haryanti, 2012).

The development of the educational world leads teachers to improve their professional skill (Dewi, 2012). Dewi et al. (2017) have researched metacognitive competence and science materials in SMP. It turns out that teachers have not yet had proper knowledge about metacognitive competence, resulting in students' low metacognitive competence. The general type of science learning materials found are in the form of printed, visual, and multimedia, but there is no such as audiovisual like film. In fact, the film is included as learning materials.

Media could be one of the solutions to overcome time and cost inefficiency in science learning. Educators need media to communicate designed information during learning process so that it will be more realistic and fun, as what Skouge found in his research about the utilizing of digital storytelling in the learning process. According to Maddin (2011), digital storytelling is the art of storytelling by combining various digital multimedia, such as text, images, narrative recordings, audio, video, and music, resulting in an interesting short film to present information on a particular topic. The information or stories presented can be historical events, personal lives, or other stories in a short duration of time. What it means for digital storytelling here is learning media in the form of an educational film that depicts the daily life of learners, containing several topics on a material. Akhlis & Dewi (2014) has developed website-based science learning media. However, videos on the website are just downloaded from other sources, instead of designed videos for science learning. Therefore, separate student worksheets are required to make the videos relevant to the topic. The upcoming idea after the research ends is, why don't we create customized videos tailored to the science learning which are also aided by question guidance focusing on the learned materials?

Researchers that refer to the development of ICT-based and conventional-based science learning media have been done before. Wulandari et al. (2013) have developed a natural science learning video. Pramana, W. D. & Dewi, N. R. (2014) developed an E-Book of Integrated Natural Science. Maharani & Dewi (2015) also have developed a website learning media, and Syahroni et al. (2016) have developed an online digital module (DIGIMON). Moreover, ICT-based development of teaching materials using traditional games has also been developed by Dewi & Akhlis (2016). Also, developed teaching media are not intended for students' metacognitive development. These studies still focus on learning outcomes only. In its development, researchers adopt the importance of students' awareness in learning that can be seen through their metacognitive abilities. The research which concerns with metacognitive ability has been done by some researchers like Christop, (2006) who examines the rules of metacognitive in learning to solve problems. Veenman et al. (2006) studied metacognitive concepts and methodologies in learning. Shannon (2008) used metacognitive strategies and learning styles to establish self-reliance in learning. Saraswati et al. (2011) used metacognitive strategies to improve students' higher-order thinking skills. Additionally, by referring to the results of research by Skouge et al. (2009) investigating the role of digital storytelling to students so that students appreciate cultural diversity through reflection of experiences presented in comic/storybook, the development of this research also utilizes IT-based digital storytelling as instructional materials designed specifically to improve students' metacognitive ability. Metacognitive ability is a capability or mental activity in the cognitive structure that a person consciously takes to regulate, control, and examine his thinking process

(Haryani, 2012). Metacognitive abilities need to be developed and improved in students to improve the high-level skills of students that will lead to increase the quality of education (Sumampouw, 2011).

The development of the educational world leads a teacher to improve the ability or professional teacher (Dewi, 2012). Dewi et al. (2017) have researched about metacognitive ability and teaching materials of science in SMP. Teachers do not yet know metacognitive ability so that the metacognitive ability of students is still relatively low. The types of science teaching materials, in general, are in the form of printed materials, visual and multimedia, but there are no science teaching materials such as the visual type of film. The film is included in the learning media. Media can be one solution to overcome the inefficiency of time and cost in science learning. Media is needed to inform messages that have been designed by educators so that learning is more realistic and fun, as Skouge's research on the use of digital storytelling in learning. Maddin (2011) stated that digital storytelling is the art of storytelling by combining various digital multimedia, such as text, images, narrative recordings, audio, video, and music, resulting in an interesting short film to present information on a particular topic. The information or stories presented can be historical events, personal lives, or other stories in short duration of time. The digital storytelling here means a learning media in the form of educational films that depict the daily life of learners in which there are several topics on a material. Akhlis & Dewi (2014) have developed Web-based IPA learning media, but the videos used are downloaded videos that are not specifically designed for science learning. Therefore, separate student work sheet to make the video can be utilized in learning. The idea that comes after the end of the study is making a special video to support the science material with the questions guide focused on the material to be learned.

Based on the description, the researchers formulate several problems, among others: (1) how is the feasibility of learning materials based on science digital storytelling ?; and (2) is the use of digital storytelling-based learning materials in science teaching effective in improving students' metacognitive abilities?

METHODS

The development and research model used is a modification of Sugiyono's development step (2015). The data taken are the feasibility and effectiveness of digital storytelling-based science materials. Data collection method used was questionnaires and tests. The subjects of this study are the seventh-grade students of SMP as many as 40 children. The questionnaire method is intended to determine the feasibility of the developed teaching materials. The questionnaire instruments used are a validation questionnaire for media experts and material experts used in the design validation stage. Before being used to retrieve the data, the questionnaire instrument was first validated by an expert and has been declared valid. The validation questionnaires of digital storytelling-based science materials by media experts include four aspects; software engineering, audio communication, visual communication, etc. Whereas the validation questionnaires material experts consist of 6 aspects; material scope, accuracy, recency and contextuality, presentation, supportive presentation, and learning presentation.

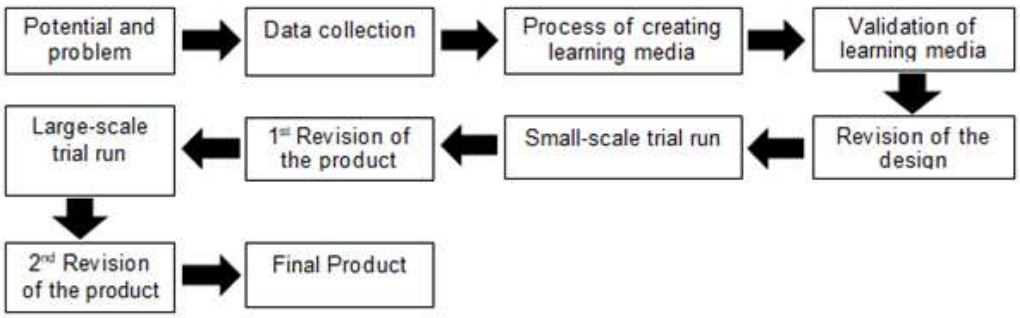

Figure 1. Research Design Development (Sugiyono, 2009 Modified Version)

Tests were assigned to measure students' metacognitive improvement. As Haryani (2012) states that metacognitive competence could be measured by the test as a metacognitive indicator of conceptual mastery. There are five metacognitive indicator levels employed to arrange the test questions, among them are: (1) awareness of thinking process and ability to describe it; (2) developing the introduction of thinking strategies; (3) systematically procedural reflection; (4) transferring knowledge and procedural experiences to other contexts, and (5) linking conceptual understanding with procedural experience. The test method used pre-test and post-test in the form of multiple choice with reasons. The test instruments used are valid and reliable. Before being used in pre-test and post-test, the first problem is tested on students who have received the materials of the classification theme to obtain validity, and reliability of the question. The improvement of students' metacognitive abilities was calculated using N-gain (Hake, 1999) and t-test of significance.

RESULTS AND DISCUSSION

The development of contextual-based digital storytelling media must be validated or assessed by experts by predetermined aspect and criteria. Assessment of media development that has been done is through one stage or two stages according to the assessment of the experts to the media till the media are proved to be feasible. Media is said to be suitable to be applied in learning if the obtained score is > 62.50% (Arikunto, 2012) and there is no revision. Questionnaire validation of digital storytelling-based science learning materials by media experts consists of 4 aspects of namely software engineering, aspects of audio communication, visual communication aspects, and other aspects. Questionnaire of material validation consists of 6 aspects: material coverage, material accuracy, up-to-date and contextual, presentation aspect, supporting the material presentation, and presentation of learning. The results of the assessment of media experts and material experts on developed materials are presented in figure 2.

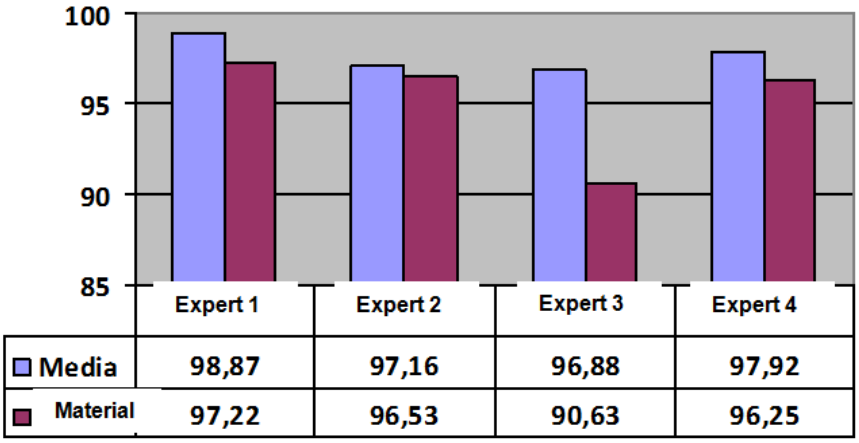

Figure 2. Results of Expert Validation

Figure 2 shows that the expert validation results for digital storytelling-based science materials get the excellent score. The average percentage of media expert judgments provides 97.70% with very reasonable criteria. The materials experts also provide a very feasible assessment with an average percentage of 95.16%. The validation of these teaching materials produces teaching materials with very reasonable criteria, but the three experts stated that learning materials need to be improved. Things to improve include: (1) addition of movie title; (2) addition of movie characters; (3) type and color of text made cheerful; (4) extended text duration; (5) text color and background contrast; (6) the writing of the narrative is tidied; (7) the selection of back sound is adjusted; (8) some hardened character sounds; (9) fixes typing errors. The suggestions are used as guidance in the improvement of teaching materials to produce appropriate teaching materials. The title of a digital storytelling movie needs to be added with the aim that students know the outline of the material to be submitted in every movie. In addition, the existence of the title is one of the components that must exist in the media digital storytelling is good, namely point of view (Robin,

2008). Therefore, each film on science-based digital storytelling materials has been added to the title, so students gain an initial knowledge of the story content of the teaching materials.

Based on the results obtained by the students on the test before and after the implementation of learning using digital storytelling-based science materials on the theme of classification, then the researcher performed calculations and comparisons to determine whether or not there is an increase in the metacognitive ability of students before and after learning using science-based digital storytelling materials. The increased metacognitive ability of students was analyzed by using N-gain and significance test. Based on the N-gain calculation, students' metacognitive abilities have improved. There are three categories of increase in N-gain, i.e., low, medium, and high. The increased metacognitive ability of students can also be viewed from each level. There are five levels of metacognitive ability. Figure 3 shows the ability improvement of students' metacognitive ability on each level

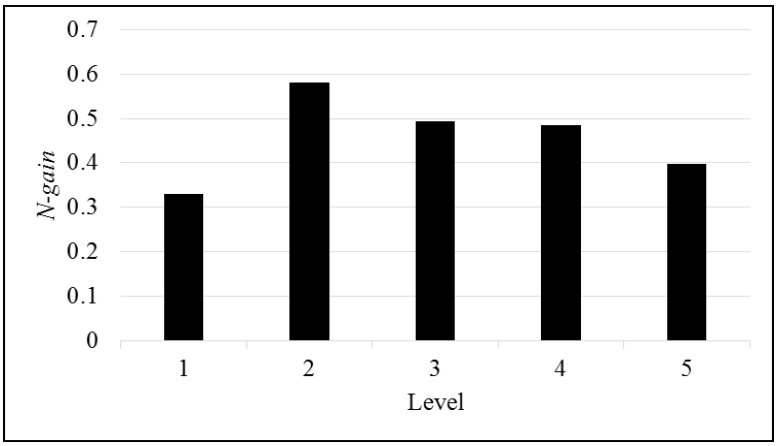

Figure 3 The Improvement of Students' Overall Metacognitive Ability for Each Level.

Note:
1. Realizing the thinking process and being able to develop it.
2. Developing the introduction of thinking strategy
3. Reflecting the procedure in an evaluative way
4. Transferring the knowledge experience and procedures of other contexts
5. Relating the conceptual understanding of procedural experience

To know the significant improvement of students' metacognitive ability, the researchers carried out significance test with the t-test at α = 5%. Data and calculation of the students' metacognitive ability improvement can be seen in table 1.

Table 1. Significance Test of the Increase of Students' Metacognitive Ability

Data	Average	Md	Sx^2d	T_{count}	t_{table}	Category
Pre-test	44,07	2368333	6369,73	7,65	2,03	Significant
Post-test	67,75					

Based on table 1. After calculation through t-test, the overall metacognitive ability of students has significant improvement, because t_{count} is bigger than t_{table}.

Measurement of students' metacognitive improvement is done by giving test questions. Haryani (2012), stated that metacognitive ability could be measured by using tests as mastery of concepts with metacognitive indicators. The test problems given are 30 questions in the form of multiple choices with reasons. There are five levels of metacognitive indicators used to make test questions.

Each level of metacognitive ability is calculated by the increase (N-gain) through the pretest and post-test scores obtained by each student. Based on the results shown in Figure 2. it can be seen that overall level 1 of metacognitive ability got the value of 0.36 with the low category, level 2 got the value of 0.56, level 3 and 4 got the value of 0.49 and 0, 45, while level 5 got a value of 0.39. Level 2, 3, 4, and five were included in the medium category. This indicates that the learning successfully improves students' metacognitive abilities on the theme of classification. The metacognitive ability level that experienced the highest increase was the second level. The result is achieved by students' discussion activity to solve the problem during the learning process. As Nugroho *et al.* (2013) said that students are greatly motivated when they involve directly in the learning process which utilizes media and discussion method. There is a component called *dramatic questions* on digital storytelling materials. *Dramatic questions* consist of provoking questions for students to lead and curiously find out information to solve problems (Engle, 2014).

The first level of metacognitive ability is to be aware of the process of thinking and being able to describe it. The indicator used for the first level is knowing what and how and identifying information. The indicator of the first level of metacognitive ability has the intention that the student can identify information from the case presented and to know what the information is and how the case in the information. There is a *point of view* component on *digital storytelling* video. It contains preliminary information of the story, showing the information that students will get from the *digital storytelling* video (Engle, 2014). The first level of metacognitive ability in this study experienced the lowest increase. This can be caused by several things, such as within the post-test when the students are less focused in understanding the problem so that the information contained in the problem cannot be digested well by the students. In addition, the first level in this metacognitive ability is the most basic level. The students frequently do the problem, so that during the learning, there is only a little explanation on how to identify information so that the results obtained by students are not maximal.

The second level of metacognitive ability is developing an introduction to thinking strategies. Indicators taken at the second level are deciding the most appropriate operation and describing the specific operation sequence. This second level leads the students to take the appropriate steps or ways for each problem. In addition, based on the indicators at level 2, the students are meant to be able to choose and determine action. The increase in N-gain at level 2 shows the highest increase. The highest increase obtained at this level can occur because, during the learning process, the student is assigned to discuss in solving the problem. Hughes (2014) stated that critical-thinking students have alternative thinking and a rational mindset by always finding and explaining a solution to the problem. According to Nugroho *et al.* (2013), students are greatly motivated when they involve directly in the learning process which utilizes media and discussion method. There is a component called *dramatic questions* on digital storytelling materials. The *dramatic questions* consist of provoking questions for students to lead and curiously find out information to solve problems (Engle, 2014)

Reflecting evaluatively the procedures is the third level in metacognitive ability. One indicator used at this level is to compile and interpret the data. Pictures and animations of the *digital storytelling* video can help students in comprehending the materials. The problems given to determine the effectiveness of science learning tools developed in improving the metacognitive ability of students are in the form of data. Problems in the form of data to make students more accurate in solving problems faced. According to the observations made, when students are working on questions in the form of data, it takes a relatively longer time than the usual problems. Difficulty in reading the data on the given problem makes the students find difficulty in working on the problem so that the increase of metacognitive ability at level 3 is classified in the medium category.

Level 4 of metacognitive ability in this study is transferring knowledge and procedural experience in other contexts. Just like level 3 that takes an indicator, level 4 also takes one indicator that is developing a procedure for the same problem. Success at level 4 is demonstrated in the students' ability to answer questions and gives the right reasons for the questions made with indicators at level 4. The work of the problem must be by observing the digital video storytelling. Students should be able to connect what they see with the problem they face. The questions present data in the form of the chart where students must be able to complete the chart before the students can answer the intended problem. Level 4 belongs to the moderate category. Students are said to have reached this level because after learning using Digital Storytelling-based science materials, there is increased activity in asking and answering questions.

Digital storytelling video contains materials which could assist students in answering questions on Independent Worksheets (IW). Hence, students should carefully watch the digital storytelling video before working on the IW. It is expected that students be able to relate what they have seen to the questions they find on the IW. Digital storytelling video is a contextual learning medium which can drive students in independently seeking information. Charts are provided on IW. Therefore, students need to complete it before answering the questions.

One component of Digital Storytelling media is a dramatic question where in the media, there are several questions. These questions provoke students to ask questions and answer questions, resulting in discussion in learning. Students are more motivated in learning when involved directly in the learning process that utilizes the media with the help of discussion methods (Nugroho et al., 2013). Digital storytelling can also increase students' learning motivation (Yang, 2012)

The last level of improvement in metacognitive ability is level 5 (linking conceptual understanding with procedural experience). The indicator used is linking observation data by discussing and selecting important information used in solving the problem. The success of level 5 is shown on the accuracy of students in answering the questions and reasons that students give to the test questions. Digital storytelling videos contain materials that help students in completing practice questions and test questions appropriately. Digital video storytelling on every lesson can improve students' metacognitive ability because by observing the digital video storytelling video, the students can find the important information they need.

Suwardy et al. (2013) stated that Science Digital Storytelling can improve students' ability in relating the theories studied in the cases experienced. The statement is in line with Botturi et al. (2014) and Niemi et al. (2014) who explained that the use of Science Digital Storytelling media in learning could improve the quality of students and grow the skills of 21st-century students. The category of metacognitive enhancement of students at this level belongs to the medium category. The learning process through observing the digital video storytelling when the students should watch, observe and understand the material in the video should be able to assist students in solving the given problem. Students will be more creative in solving a problem when students are directly involved in everyday life (Sambada, 2012).

Metacognitive capabilities that have been calculated through N-gain have increased. The increase is then analyzed again using t-test. The t-test is a test of significance to determine whether the improvement of students' metacognitive ability through digital-based science storytelling materials on a classification theme is significantly developed or not. Additionally, this research also found how big the value of significance is if it is proven that the metacognitive ability increased. Based on the calculation in Table 1, it can be seen that the improvement of students' metacognitive competence through a guided inquiry-based science learning device with digital storytelling aid on thematic classification. The results are obtained through a series of research process development of teaching materials based on science digital storytelling on the theme of classification that has been done to give a good influence on students' metacognitive ability. Rahmawati (2015), stated that learning using digital media storytelling can also improve students' achievement. Iskandar (2016), stated that the relationship between the belief in students with the intelligence, awareness, and knowledge of the level of tasks that he did and how to overcome them can be regarded as metacognitive ability. Flavell suggests that even students' metacognition generally needs to be developed for the following reasons: (1) students should have a tendency to think a lot, in the sense that more metacognition requires more cognition; (2) students' thinking can be erroneous and tends to be wrong, and in these circumstances require good monitoring and arrangement; (3) the student must be willing to communicate, explain, and give clear reasons for his or her thoughts to other students as well as to himself, this activity, of course, requires metacognition; (4) to survive and be successful, students need to plan for the future and critically evaluate other plans; (5) if the student has to make a tough decision, it will require metacognitive skills; and (6) the student must have the need to infer and explain psychological events on himself and others. The tendency to engage in such metacognitive actions indicates social cognition (Haryani, 2012).

CONCLUSION

Based on the results of research, it can be concluded that the Digital Storytelling-based science teaching materials that have been developed is declared as appropriate for teaching mate-

rials of SMP class VII with the average percentage score of 97,70% at media aspect and 95,16% at material aspects. Digital Storytelling-based science teaching materials on classification themes have been developed effectively to significantly increase metacognitive abilities.

REFERENCES

Akhlis, I., & Dewi, N. R. (2014). Pengembangan Perangkat Pembelajaran Science Berorientasi Cultural Deviance Solution Berbasis Inkuiri Menggunakan ICT untuk Mengembangkan Karakter Peserta Didik. *Jurnal Pendidikan IPA Indonesia*, *3*(1), 86-94.

Ali, M. (2009). Pengembangan media pembelajaran interaktif mata kuliah medan elektromagnetik. *Jurnal Edukasi Elektro*, *5*(1), 11-18.

Arikunto, S. (2012). *Dasar-Dasar Evaluasi Pendidikan*. Jakarta: Bumi Aksara.

Botturi, L., Bramani, C., & Corbino, S. (2014). Digital storytelling for social and international development: from special education to vulnerable children. *International Journal of Arts and Technology*, *7*(1), 92-111.

Christoph, L. H. (2006). *The role of metacognitive skills in learning to solve problems*. SIKS.

Dewi, N. R. (2012). Kompetensi Mahasiswa IPA Dalam Merencanakan Penelitian Ilmiah Bidang Sains. *Jurnal Pendidikan IPA Indonesia*, *1*(1), 71-74.

Dewi, N. R., & Akhlis, I. (2016). Pengembangan Perangkat Pembelajaran IPA Berbasis Pendidikan Multikultural Menggunakan Permainan untuk Mengembangkan Karakter siswa. *Unnes Science Education Journal*, *5*(1), 1098-1101.

Dewi, N. R., Wibowo, S. W. A., & Savitri, E. N. (2017). The Analysis of Science Learning Sources Reviewed from the Meta-Cognitive Ability of The VII Grade the Students of SMP Negeri 2 Boja. *Unnes Science Education Journal*. *6*(2), 1625-1632.

Hake, R. R. (1999). Analyzing change/gain scores. *Unpublished.[online] URL: http://www. physics. indiana. edu/~ sdi/AnalyzingChange-Gain. pdf*. Acessed on August, 12, 2017.

Haryani, S. (2012). Membangun Metakognisi dan Karakter Calon Guru Melalui Pembelajaran Praktikum Kimia Analitik Berbasis Masalah. *Skripsi. Semarang: FMIPA Universitas Negeri Semarang*.

Hughes, C. (2014). Theory of Knowledge aims, objectives and assessment criteria: An analysis of critical thinking descriptors. *Journal of Research in International Education*, *13*(1), 30-45.

Iskandar, S. M. (2016). Pendekatan keterampilan metakognitif dalam pembelajaran sains di kelas. *ERUDIO (Journal of Educational Innovation)*, *2*(2), 13-20.

Kemendikbud. (2013). *Kurikulum 2013 Kompetensi Dasar Sekolah Menengah Pertama (SMP)/ Madrasah Tsanawiyah (MTs)*. Jakarta: Kementerian Pendidikan dan Kebudayaan.

Maddin, E. (2011). Using TPCK with Digital Story Telling to Investigate Contemporary Issues in Educational Technology. *Journal of Instructional Pedagogies*, 2-6.

Maharani, D. W., & Dewi, N. R. (2015).The Implementation of Science Inquiry-Based Website Oriented by Cultural Deviance Solution to Instill Students' Character and Independence. *Jurnal Pendidikan IPA Indonesia*. *4*(1), 25-30.

Niemi, H., Harju, V., Vivitsou, M., Viitanen, K., Multisilta, J., & Kuokkanen, A. (2014). Digital storytelling for 21st-century skills in virtual learning environments. *Creative Education*, *5*(9), 657-671.

Nugroho, A. P., Raharjo, T., & Wahyuningsih, D. (2013). Pengembangan Media Pembelajaran Fisika Menggunakan Permainan Ular Tangga Ditinjau dari Motivasi Belajar Siswa Kelas VIII Materi Gaya. *Jurnal Pendidikan Fisika*, *1*(1), 11-18.

Pramana, W. D., & Dewi, N. R. (2014). Pengembangan E-Book IPA Terpadu Tema Suhu dan Pengukuran untuk Menumbuhkan Kemandirian Belajar Siswa. *Unnes Science Education Journal*, *3*(3), 602-608.

Rahmawati, R. N. (2015). Penggunaan CD Interaktif dan *Digital Storytelling* Berbasis Kontekstual sebagai Media Pembelajaran Matematika. *Seminar Nasional Matematika dan Pendidikan Matematika.* Yogyakarta: Universitas Negeri Yogyakarta.

Robin, B. R. (2008). Digital storytelling: A powerful technology tool for the 21st century classroom. *Theory into practice*, *47*(3), 220-228.

Sambada, D. (2012). Peranan Kreativitas Siswa Terhadap Kemampuan Memecahkan Masalah Fisika dalam Pembelajaran Kontekstual. *Jurnal Penelitian Fisika dan Aplikasinya (JPFA)*, *2*(2), 37-47.

Sastrawati, E., & Rusdi, M. Syamsurizal.(2011). *Problem-Based Learning, Strategi Metakognisi, dan Keterampilan Berpikir Tingkat Tinggi Siswa. Tekno-Pedagogi, ISSN*, 1-14.

Shannon, S. V. (2008). Using metacognitive strategies and learning styles to create self-directed learners. *Institute for Learning Styles Journal*, *1*(1), 14-28.

Sholihat, N. (2015). *Pengaruh Pembelajaran Ipa Terpadu Tipe Integrated Terhadap Penguasaan Konsep Dan Berpikir Kritis Siswa Smp Pada Topik Tekanan* (Doctoral dissertation, Universitas Pendidikan Indonesia).

Skouge, J. R., & Rao, K. (2009). Digital Storytelling in Teacher Education: Creating Transformations through Narrative. *Educational Perspectives*, *42*(1-2), 54-60.

Sugiyono. (2015). *Metode Penelitian Pendidikan: Pendekatan Kuantitatif, Kualitatif, dan R & D*. Bandung : Alfabeta.

Sumampouw, H. M. (2011). Keterampilan Metakognitif dan Berpikir Tingkat Tinggi dalam Pembelajaran Genetika (Artikulasi Konsep dan Verifikasi Empiris). *Bioedukasi: Jurnal Pendidikan Biologi*, *4*(2), 23-39.

Suwardy, T., Pan, G., & Seow, P. S. (2013). Using digital storytelling to engage student learning. *Accounting Education*, *22*(2), 109-124.

Syahroni, M. W., N. R. Dewi & Kasmui. 2016. The Effect of Using Digimon (Science Digital Module) with Scientific Approach to The Visualization of Students' Independence and Learning Results. *Jurnal Pendidikan IPA Indonesia. 5*(1), 116-122.

Veenman, M. V. J. dkk. (2006). Metacognition and Learning: Conceptual and Methodological Considerations. *Springer*. *1(1):* 3-14.

Wulandari, F. R. A., Dewi, N. R., & Akhlis, I. (2013). Pengembangan CD Interaktif Pembelajaran IPA Terpadu Tema Energi dalam Kehidupan untuk Siswa SMP. *Unnes Science Education Journal*, *2*(2), *262-268.*

Yang, Y. T. C., & Wu, W. C. I. (2012). Digital storytelling for enhancing student academic achievement, critical thinking, and learning motivation: A year-long experimental study. *Computers & education*, *59*(2), 339-352.