Indonesian Journal of Science and Education
Volume 05, Nomor 02, 2021, pp: 98~105
ISSN: 2598-5213e-ISSN: 2598-5205, DOI: 10.31002/ijose.v5i2.4228
e-mail: ijose@untidar.ac.id, website: jurnal.untidar.ac.id/index.php/ijose

The Effectiveness of Use of Multi Representation-Based Teaching Materials in Science Learning in Junior High School: Systematic Literature Review

Sulystia Angelina[1)], Susilawati[2a)], Niki Dian Permana[3)] Rian Vebrianto[4)]
[1,2,3,4]Jurusan Tadris IPA, UIN Sultan Syarif Kasim Riau, Pekanbaru
e-mail: [a)] susilawati@uin-suska.ac.id

Received: August, 6th 2021 *Revised:* *Accepted: 13 Oktober 2021*

ABSTRACT

Student inability to multi-representation in science learning in junior high school and teacher ability to provide teaching materials according to the characteristics of students who have difficulty in multi-representation causes the learning process cannot achieve the desired results. It affects the low learning outcomes and students' cognitive abilities. Therefore, this study aims to determine the types of multi-representation-based teaching materials in science learning in junior high schools and the effectiveness of using multi-representation-based teaching materials used in science learning in junior high schools. The method used is a systematic literature review using PRISMA diagrams. The database used to search for literature uses two digital libraries, namely Google Scholar and Garuda. For the selected literature to be relevant, it uses the keyword teaching materials and multi-representation. The next step is to get scientific articles published from 2016 to 2021 which discuss the use of multi-representation-based teaching materials in science learning in junior high schools. The results of the scientific article search contained eight articles that would be analyzed and synthesized. The analytical technique used is the narrative method by grouping the extracted data. The results show the types of multi-representation-based teaching materials in science learning are printing and non-printing teaching materials. Printed teaching materials are modules, books, and worksheets, while non-printed teaching materials are in the form of web simulations. The use of multi-representation-based teaching materials has proven to be effective in the science learning process in junior high schools.

Keywords: systematic literature review, teaching materials, multi-representation, junior high school.

INTRODUCTION

The implementation of the 2013 curriculum in schools has begun from primary education to higher education levels. The development of the 2013 curriculum focuses on improving the mindset, strengthening curriculum governance, deepening and expanding the material. In addition, it enhances the learning process and adjusts what is desired and produced. Especially in science learning in the 2013 curriculum, science learning is related to how to find out about nature systematically, so that science does not merely contain a collection of knowledge in the form of facts, concepts, or principles but is also a process of discovery (Pusat Kurikulum 2009). Susilawati (2012), defines science as a unit of the process, attitude, and outcome. Therefore, science learning is learning to construct and discover the identity through an active, creative, effective, and fun learning process. Science learning emphasizes finding out or doing. These skills are inquiry process skills which include observing, measuring, lengthening, asking questions, formulating hypotheses, planning experiments to respond to questions, classifying, processing, and analyzing data. In addition, it also applies ideas to new situations, uses simple equipment, and communicates information in various ways, namely with

pictures, verbally, in writing, and others (Trianto 2010).

Implementing science learning in the 2013 curriculum requires the preparation of various components. One of which is teachers and other education staff as curriculum implementers in the field. The substantial one that needs teachers to prepare in implementing the curriculum in the classroom is to produce a learning design concerning the applicable curriculum. The teacher is one of the tools that are the key to the success of education. One of the teacher's tasks is to make proper teaching materials to support the learning process.

Based on the experience of researchers during PPL in one of the schools in Pekanbaru, some teachers still have difficulty designing science learning teaching materials according to the needs and characteristics of students. Therefore, teachers only use teaching materials published by publishers and textbooks from the government. The teaching materials employed are still unfit to support students learn independently. Consequently, learning is still teacher-centered. Without encouragement from the teacher, students are less motivated to read on their own. The teaching materials also tend to implement verbal representations and images. Therefore, the students cannot represent symbols and mathematics during science learning. Vicka Puspitasari's research stated that students are more outstanding at mastering questions in verbal form and mathematical representations. Students have difficulty when encountered questions about image representation (Puspitasari, Wiyanto, and Masturi 2018).

The reality on the ground proves that using teaching materials in science learning is still less effective. Besides, effectiveness is crucially important because it is a barometer to measure educational success. It reflects the extent to which the level of success students have to achieve predetermined educational goals.

So the alternative solution to increase students' activities and learning outcomes in science are to use multi-representation science-based teaching materials. This multi-representation-based teaching material can be used as the primary learning resource or as a companion. Teaching materials are the learning materials or tools used by teachers and arranged systematically in teaching and learning activities (Kelana and Pratama 2019). Meanwhile, multi-representation also means representing the same concept in different formats, including verbal, pictures, graphics, and mathematics (Abdurrahman, Liliasari, A. Rusli 2011). Hence, multi-representation science teaching materials are tools used in science learning to express a concept presented in verbal, mathematical, picture, and graphic formats. Science multi-representation-based teaching materials also contain experimental instructions and exercises on multi-representation-based ones.

The idea of this research is from several previous researchers. Research by Ardiansyah, Ertikanto, dan Rosidin (2019), states that students who use multi-representation-based contextual learning modules can improve students' critical thinking skills. In Damayanti, Mahardika and Indrawati (2016), the research applied a discovery learning model assisted by Macromedia flash animation media with integrated worksheets with multi-representations in physics learning. It states that student activity increases during learning, learning outcomes, and retention of physics learning outcomes produce a significant effect. Likewise, with research by Sari, Purwana (2021), stated that students responded positively to multi-representation-based E-books on simple harmonic vibration material.

Based on this background, the researcher is interested in investigating the types of multi-representation-based

teaching materials and the effectiveness of using multi-representation-based teaching materials in science learning in junior high schools through a literature review. This article is to strengthen other researches that stated multi-representation-based teaching materials are effective in science learning.

RESEARCH METHOD

This research is a systematic review using the Preferred Reporting Items for Systematic Reviews and Meta-analyses method (PRISMA). To get maximum results, writing this literature is based on the Research Question (RQ). The purpose of structuring this research question is to focus more on the literature review and to facilitate researchers in obtaining related data. The summary of the Research Question (RQ) in this study is in Table 1 below.

Tabel 1. Research question

	Research Question	Motivation
1)	What are the multi-representation-based teaching materials used in science learning in junior high school?	Identify the types of multi-representation-based teaching materials used in science learning in junior high schools.
2)	How is effective the use of multi-representation-based teaching materials in science learning in junior high school?	Identification of the effectiveness of using multi-representation-based teaching materials in science learning in junior high schools

The articles used in this literature review are articles obtained using Google Scholar, Digital Reference Gateway (Garuda), Crossref, and DOAJ. The search for relevant research literature on the topic of this research is carried out with the keywords: "teaching materials, multi-representation." The literature search was from February to April 2021. The sorting of articles was according to the research topic. So, ten research articles were collected and considered representative of all research articles on using multi-representation-based teaching materials in science learning in junior high schools. The ten articles have been published in the last five years. In selecting articles, inclusion and exclusion criteria are to determine the primary research. The results of data search, with these criteria, will be operated by the researchers to review articles. The inclusion and exclusion criteria in this literature are in Table 2 below.

Table 2. Inclusion and exclusion criteria

Inclusion Criteria	1) Research articles published in 2016-2021, 2) Research topics include science learning, 3) Research subjects are limited to the junior high school level, 4) The research article method is in the form of experimentation and development. Specifically for development articles, researchers only select articles that carry out research up to the field trial stage.
Exclusion Criteria	1) Research articles that are not accessed in full, 2) Literature in the form of thesis and dissertation.

After determining the inclusion and exclusion criteria, then selecting the articles to be reviewed. The following is a chart of the article selection process.

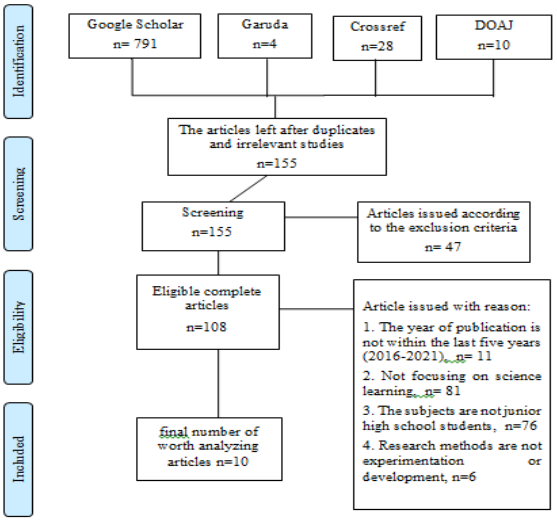

Figure 1. PRISMA Diagram

The data analysis technique used is the narrative method. The method describes the effectiveness of using multi-representation-based teaching materials in

science learning in junior high schools. The effectiveness principle refers to the opinion of Kalvin, Utami, dan Warneri (2013). They explained using teaching materials is effective if the indicators in science learning consist of the learning process, student learning motivation, and student learning outcomes. It is effective if they meet at least two of the three indicators. In addition, learning outcomes indicators must be achieved.

RESULTS AND DISCUSSION

Based on the results, there are four types of multi-representation-based learning materials used in science learning in junior high school. They are modules, worksheets, books, and interactive multimedia. Table 3 shows the multi-representation-based teaching materials in science learning used at the junior high school. Their references are as follows.

Table 3. Multi-representation-based teaching materials in science learning in junior high schools

No	Teaching materials	Reference
1	Module	(Stepanus Sahala Sitompul, 2019) (Devi Eka Farah Azizah, Albertus Djoko Lesmono, Subiki, 2017) (Yesinta, Andy, Stepanus, 2017)
2	Student Worksheet	(Abdurrahman, Cris Ayu Setyaningsih, Tri Jalmo, 2019) (Nur Balqis Mutiaa, dan Zuhdan Kun Prasetyob, 2018) (D F Hidayati, Abdurrahman dan Sunyono, 2018)
3	Book	(Ana Pratiwi, Husna Amalya Melati, Rahmat Rasmawan, 2016) (Ida Fitriyati, Arif Hidayat, Munzil, 2017)
4	Interactive Multimedia	(Dira Oktaviana, I Ketut Mahardika, Aris Singgih Budiarso, 2020) (Arief Muliandi, Nur Endah Susilowati, Siti Rahmah, Sri Wahyuni, Dadi Rusdiana, 2021)

The types of multi-representation-based teaching materials in Table 3 can be described in graphical form in Figure 2. as follows.

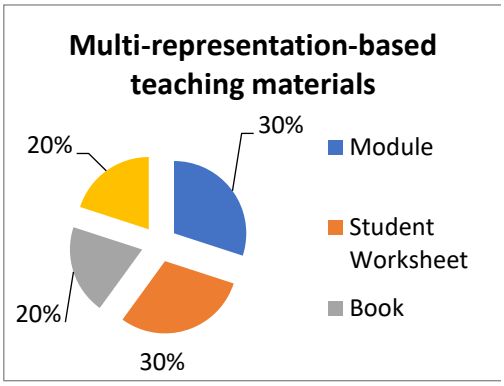

Figure 2. Multi-representation-based teaching materials in science learning in junior high schools

Figure 2. shows that the use of multi-representation-based teaching materials used in science learning in junior high schools predominantly uses printed teaching materials in the form of modules and worksheets, each with a percentage of 30%. Then most of them use printed teaching materials in the form of books (20%) and non-printed teaching materials in interactive multimedia (20%). Therefore, this data proves that in the 2016-2021 range, articles discussing the use of multi-representation-based teaching materials in science learning in junior high schools mostly use printed teaching materials in the form of modules and worksheets.

Based on the results, using multi-representation-based teaching materials in science learning in junior high schools is functional. It is evidenced in the research of Sitompul (2019), that by using a multi-representation-based module, 80% of students succeed in the test reaching the student passing grade. Using a multi-representation-based module, students can live and carry out their learning activities as much as possible, either under the teacher's guidance or without. Students can assess and know their learning outcomes on an ongoing basis, and students become the center point of teaching and learning activities. Furthermore, research by Azizah, Lesmono, and Subiki (2017), developed a multi-representation-based

module that scored effectiveness of 280 and an average of 38.08 with a positive category. Multirepresentation-based modules make students not only study science learning as a product, concepts memorizing, theories, and laws, but can also construct their knowledge. In addition, multi representation has three main functions, complementing, limiting interpretation, and building understanding (Mahardika, Setyawan, dan Rusdiana 2010). It is on the opinion of Khotimah, Nyeneng, dan Sesunan (2017). They stated the ultimate reason for using a multi-representation-based module in learning is that there are multiple intelligences, visualization for the brain, helps construct other representations, is beneficial for qualitative reasoning and mathematical representations as a tool for quantitative reasoning.

In multi-representation-based modules, there are verbal representations, graphic representations, mathematical representations, and image representations. Verbal representation is a method used in learning or as a conclusion. Mathematical representations are to solve quantitative problems. Using graphic representations in explaining various concepts and image representations relationships can help visualize an abstract thing. Based on research conducted by Abdurrahman, Setyaningsih, and Jalmo (2019), using multi-representation-based worksheets to get an average N-Gain value of 0.34, it shows a significant difference between students' critical thinking skills from pre-test to post-test with moderate criteria. Likewise, the research of Mutiaa and Prasetyo (2018), results show that by using multi-representation-based worksheets, the average n-Gain score for the experimental group is higher than the control group that does not use multi-representation-based worksheets. The n-Gain value for the experimental group was 0.47 categorized as medium. The n-Gain score for the control group was 0.28 in the low category. The difference in n-gain between the control and the experimental group explains multi-representation-based worksheets for specific topics of environmental pollution can improve science process skills. By implementing multiple representations in the worksheet, it can describe the concept of learning and make science learning clearer (Prain and Tytler 2012). In addition, Ismet (2013), stated representations - graphs, diagrams, and animations - can encourage students' understanding of science. They do not merely represent abstract science concepts but also occupy a significant role in their memory. Therefore, this multi-representation-based worksheet is suitable for use in science learning in junior high schools. It is in line with the opinion of Amali, Kurniawati, and Zulhiddah (2019), that worksheets can be as supporting teaching materials in learning to increase the effectiveness and efficiency of achieving learning competencies.

Furthermore, based on the results of research by Pratiwi, Melati, and Rasmawan (2016), the average proportion of textbooks developed was 84.99% (very high) in terms of the suitability of the content (83.33%), presentation (83.75%), language (87.5%), and illustration aspects (85.41%). Hence, the textbooks developed are very suitable to be used as teaching materials in learning. In this regard, Fitriyati, Hidayat, dan Munzil (2017), obtained the effectiveness test results of multi-representation-based books to improve higher-order thinking skills (97) and scientific reasoning (12).

Based on research by Oktaviana Oktaviana, Mahardika, and Budiarso (2020), by conducting interactive multimedia-assisted science learning using PhET simulations in the experimental group, the N-Gain value of 0.7 or 70% is in the high category. Meanwhile, in the control group that learns science without the aid of PhET simulation, the N-Gain value from the representation ability of the

control group is 0.3 or 30%, which is in the low category. Hence, guided inquiry learning with simulation-assisted PhET is more effective in improving students' science image representation abilities in junior high schools rather than learning using conventional models with a percentage difference of 40%.

The research of Muliandi et al. (2021), shows the validation results by the validator indicate interactive multimedia is very suitable as teaching material. The implementation of interactive media also demonstrates it can improve students' scientific literacy skills. The results of the paired t-test show a value of 0.000 which means it is less than 0.05. Thus, there is a mean difference between pre-test and post-test as an effect of using interactive multimedia. Permana (2018), stated students practice critical thinking skills with website assistance in the learning process. Students can find the concepts they want to obtain easier with the help of links, simulations of physical phenomena, virtual practicums, and video displays in interactive multimedia on the website.

Multi-representation-based teaching materials can be as one learning tool in science learning both for students and teachers. It also improves student learning outcomes that reach the student passing grade. Multi-representation-based teaching materials also enhance students' cognitive abilities, multi-representation abilities, critical thinking skills, science process skills in the learning process, scientific thinking skills, and higher-order thinking. Student responses to multi-representation-based teaching materials showed a positive effect, meaning students were interested and satisfied while using multi-representation-based teaching materials in the science learning process in junior high schools.

CONCLUSION

Based on the literature review of ten scientific articles, multi-representation-based teaching materials used in science learning in junior high schools can be in the form of print or non-print. The printed teaching materials used are modules, books, and worksheets. Besides, the non-printed teaching materials used can be in the form of interactive multimedia. The use of multi-representation-based teaching materials showed that it was very effective as a learning resource for teachers and students in science learning in junior high schools.

Based on the review, the researchers suggest multi-representation-based teaching materials can be used in the science learning process in junior high schools. The teaching materials used can be printed or non-printed. However, the most frequently used multi-representation-based teaching materials are the printed teaching materials in modules and worksheets. Since by using a multi-representation-based module, students can read or study the module independently. The characteristics of this multi-representation-based module include verbal, mathematical, graphic, and image representations, learning instructions, competencies to be achieved, material, supporting information, practice questions, work instructions, evaluations, and feedback as evaluations.

Types of multi-representation-based teaching materials that can be used in addition to modules can be in the form of books, worksheets or web simulations. This teaching material has proven its effectiveness when used in science learning in junior high school. Furthermore, the researcher suggests using the results of this study as a reference in similar research activities to conduct trial research on a large scale or wider scope.

REFERENCES

Abdurrahman, Liliasari, A. Rusli, &. Bruce

Waldrip. 2011. "Implementasi Pembelajaran Berbasis Multi Representasi Untuk Peningkatan Penguasaan Konsep Fisika Kuantum." *Jurnal Pendidikan Fisika* 15(1).

Abdurrahman, Cris Ayu Setyaningsih, and Tri Jalmo. 2019. "Implementating Multiple Representation-Based Worksheet to Develop Critical Thinking Skills." *Journal of Turkish Science Education* 16(1):138–55.

Amali, Khairul, Yenni Kurniawati, and Zulhiddah. 2019. "Pengembangan Lembar Kerja Peserta Didik Berbasis Sains Teknologi Masyarakat Pada Mata Pelajaran IPA Di Sekolah Dasar." *Journal of Natural Science and Integration* 2(2):191–202.

Ardiansyah, Sigit, Chandra Ertikanto, and Undang Rosidin. 2019. "Pengaruh Penggunaan Modul Pembelajaran Kontekstual Berbasis Multiple Representations Pada Materi Fluida Statis Terhadap Kemampuan Berpikir Kritis Siswa." *Journal Pendidikan Fisika* 7(2):265–78.

Azizah, Devi Eka Farah, Albertus Djoko Lesmono, and Subiki. 2017. "Pengembangan Modul Pembelajaran Berbasis Kontekstual Disertai Multirepresentasi Pada Pokok Bahasan Kalor Dan Perpindahannya Di SMP." Pp. 1–6 in *SEMINAR NASIONAL PENDIDIKAN FISIKA 2017 "Peran Pendidikan, Sains, dan Teknologi untuk Mengembangkan Budaya Ilmiah dan Inovasi terbarukan dalam mendukung Sustainable Development Goals (SDGs) 2030"*. Jawa Timur: Universitas Jember.

Damayanti, S., I. Mahardika, and I. Indrawati. 2016. "Penerapan Model Discovery Learning Berbantuan Media Animasi Macromedia Flash Disertai LKS Yang Terintegrasi Dengan Multirepresentasi Dalam Pembelajaran Fisika Di SMA." *Jurnal Pembelajaran Fisika* 4(4):357–64.

Fitriyati, Ida, Arif Hidayat, and Munzil. 2017. "Pengembangan Perangkat Pembelajaran IPA Untuk Meningkatkan Kemampuan Berpikir Ilmiah Dan Berpikir Tingkat Tinggi Siswa Sekolah Menengah Pertama." *Jurnal Pembelajaran Sains* 1(1):27–34.

Ismet. 2013. "Dampak Program Perkuliahan Mekanika Berbasis Multipel Representasi Terhadap Kecerdasan Spasial Mahasiswa Calon Guru." *Jurnal Pendidikan Fisika Indonesia* 9(2):132–43.

Kalvin, Heri, Sri Utami, and Warneri. 2013. "Peningkatan Aktivitas Pembelajaran Ilmu Pengetahuan Alam Melalui Metode Inkuiri Kelas V Sekolah Dasar 18 Berangan Pale." *Jurnal Pendidikan Dan Pembelajaran Khatulistiwa* 2(8):1–10.

Kelana, Jajang Bayu, and D. Fadly Pratama. 2019. *Bahan Ajar IPA Berbasis Literasi Sains*. Bandung: LEKKAS.

Khotimah, Khusnul, I. Dewa Putu Nyeneng, and Feriansyah Sesunan. 2017. "Pengaruh Kemampuan Berpikir Kritis Dan Respon Bahan Ajar Multirepresentasi Terhadap Hasil Belajar." *Jurnal Pembelajaran Fisika* 5(3):1–12.

Mahardika, K. .., A. Setyawan, and D. Rusdiana. 2010. "Kajian Representasi Verbal, Matematik, Gambar Dan Grafis (VMG2) Dalam Konsep Pengembangan Gerak." *Jurnal Saintifika* 12(2):183–93.

Muliandi, Arief, Nur Endah Susilowati, Siti Rahmah, Sri Wahyuni, and Dadi Rusdiana. 2021. "MRIM (Multiple Representation-Based Interactive Multimedia): Is It Good to Improve Students' Scientific Literacy?" *U-Teach: Journal Education of Young Physics Teacher* 2(1):9–21.

Mutiaa, Nur Balqis, and Zuhdan Kun Prasetyo. 2018. "The Effectiveness of Students' Worksheet Based on

Multiple Representations to Increase Science Process Skills." *International Journal of Sciences: Basic and Applied Research* 41(1):158–66.

Oktaviana, Dira, I. Ketut Mahardika, and Aris Singgih Budiarso. 2020. "The Effectiveness of Guided Inquiry Learning Assisted by Phet Simulation to Improve the Capability of Representation Image of Science Student in Junior High School." *ScienceEdu* 3(2):43–47.

Permana, Niki Dian. 2018. "Penerapan Model Pebelajaran Learning Cycle 7E Berbantuan Website Untuk Meningkatkan Keterampilan Berpikir Kritis Siswa Pada Materi Kinematika Gerak Lurus." *Journal of Natural Science and Integration* 1(1):11–41. doi: 10.24014/jnsi.v1i1.5187.

Prain, V., and R. Tytler. 2012. "Learning Through Constructing Representations in Science: A Framework of Representational Construction Affordances." *International Journal of Science Education* 34(17):2751–73.

Pratiwi, Ana, Husna Amalya Melati, and Rahmat Rasmawan. 2016. "Pengembangan Buku Ajar Pemisahan Campuran Dengan Pendekatan Konstruktivistik Dan Multirepresentasi Kelas VII SMP." *Jurnal Pendidikan Dan Pembelajaran Khatulistiwa* 4(9):1–12.

Pusat Kurikulum, Balitbang Depdiknas. 2009. *Panduan Pengembangan Pembelajaran IPA Terpadu SMP/MTS*. Jakarta Pusat: Balitbang Depdiknas.

Puspitasari, Vicka, Wiyanto, and Masturi. 2018. "Implementasi Model Guided Discovery Learning Disertai LKS Multirepresentasi Berbasis Pemecahan Masalah Untuk Meningkatkan Pemahaman Konsep Siswa." *Unnes Physics Education Journal* 7(3):18–27.

Sari, Resi Helina, Unang Purwana, and Ika Mustika Sari. 2021. "Penyusunan E-Book Fisika SMA Berbasis Multi Representasi Menggunakan Platform Storyline 3 Pada Materi Getaran Harmonik Sederhana." *WaPFi (Wahana Pendidikan Fisika)* 6(1):104–9.

Sitompul, Stepanus Sahala. 2019. "Pengembangan Bahan Ajar Dalam Konsep Ipa/Fisika Dengan Pendekatan Multirepresentasi Di Sekolah Menengah Pertama (SMP) Kecamatan Kembayan Kabupaten Sanggau." Pp. 165–74 in *Seminar Nasional Pendidikan MIPA dan Teknologi (SNPMT II) 2019 "Peningkatan Mutu Pendidikan MIPA dan Teknologi di Era Revolusi Industri 4.0."* Pontianak: Fakultas Pendidikan MIPA dan Teknologi IKIP PGRI Pontianak.

Susilawati. 2012. "Karakter Religius Pembelajaran IPA." *Media Pendidikan* 17(1):98–114.

Trianto. 2010. *Model Pembelajaran Terpadu*. Jakarta: Bumi Aksara.