JISE 8 (2) 2019 : 173 - 182

Journal of Innovative Science Education

http://journal.unnes.ac.id/sju/index.php/jise

Development of Research-Based Flowering Plants Catalog as a Supplement of Biology Teaching Materials in High School

Anita Sulistyawati✉, Dyah Rini Indriyanti, Ari Yuniastuti

Universitas Negeri Semarang, Indonesia

Article Info

Article History:
Received May 2019
Accepted June 2019
Published August 2019

Keywords:
Flowering Plants Catalog, supplementary teaching materials, environtmental potency.

Abstract

Species richness of flowering plants in Bandungan area of Semarang is one of the potency that can be used as a biology learning resources. Those pontency can be developed as teaching material. This study aims to identify flowering plants in Bandungan area that are used as material for developing learning catalogs. This study uses the Research and Development (R&D) approach with the ADDIE model. Catalog are validated by material experts and media experts before use. The catalog trial was conducted on 40 students of X IPA classes using the one group pretest-posttest design. The results show that the catalog is declared 'very valid' by material experts and media experts with an average percentage of 88.72%. Catalog stated to be effective in improving learning outcomes with an average N-gain of 0.55 ('medium' criteria). Catalog get positive responses from teacher and students in the 'very worthy' category with an average percentage of 88.11%.

✉ Alamat korespondensi:
Kampus Pascasarjana Jl Kelud Utara III, Semarang 50237
E-mail: anitasuliztya.as@gmail.com

p-ISSN 2252-6412
e-ISSN 2502-4523

INTRODUCTION

Learning resources are one of the important components in learning that can be obtained from anywhere. The utilization of the environment as a source of biology learning has not been done much, even though the environment provides lots of potency.

Bandungan is an area located in Semarang distric that potential to be used as a learning resource. The Strategic Data of Semarang Regency (2015) noted that Bandungan area became the center of horticultural cultivation such as vegetables, fruits and ornamental plants, as well as agricultural crops. About 61.86% of the area is used as agricultural land. It indicates the condition of fertile areas that support plant habitat. Flowering plants as the dominant vegetation in the area belonging to the Angiospermae subdivision, which is one of the sub topics in biology materials in High School.

Preliminary studies were conducted through interviews with tenth grade biology teacher in MA Futtuhiyah Kudu Semarang obtained information that students had learning difficulties in plantae especially Angiosperm sub-subject material in classifying monocot and dicot plants, which was characterized by more than 50% of tenth students in the 2016/2017 academic year scored below the minimum completeness criteria (KKM). Students have difficulty understanding the discussion of Angiosperms in distinguishing monocot and dicot plants. Furthermore, it was found that the main learning resources used so far were textbooks and student worksheets that lacked images, examples were still general, dominated textual explanations, and less contextual because they did not display the environment potency. The use of the environment around the school as a learning resource is inadequate because there is little availability of plants, meanwhile, there is no independent teaching materials developed by teacher.

The solution to this problem can be done by developing supplementary teaching materials that put forward the visual display and include contextual insights. Catalog can be used as an alternative teaching materials that display material interestingly by utilizing the potency of the environment. Catalog is a list in the order containing the objects' information in certain places that are physically in the book form. Catalog that has developed based on the environment potency enriched with images can improve student learning outcomes (Husna et al., 2018; Widalismana et al., 2016).

This study aims to collect data and identify the species richness of flowering plants in Bandungan area of Semarang to be used as material for developing Flowering Plants Catalog. The catalog can be used as a supplement for biology teaching materials in high schools on plantae material.

METHODS

This study uses the Research and Development (R & D) approach which is designed using the ADDIE model with components that include Analysis, Design, Development, Implementation, and Evaluation. The study was conducted in two stages, first step was collecting data about speciess richness of flowering plants in Bandungan area of Semarang and secondly, developing catalog of the data obtained. Validity of developed catalog assessed by material and media experts.

Catalog that was stated valid are implemented in trials at MA Futtuhiyah Kudu Semarang in 40 students of X IPA 1 and X IPA 2 classes at 2017/2018 academic year using one group pretest-posttest design. The trial was conducted to determine the feasibility and effectiveness of the developed catalog. Data obtained from the results of implementation in the form of student and teacher responses to the catalog obtained through questionnaires and cognitive learning outcomes obtained through tests. Catalog was stated 'worthy' if the student and teacher response criteria > 62.50% and stated as 'effective' if the N-gain criteria based on students' cognitive learning outcomes > 0.3.

RESULTS AND DISCUSSION

Species Richness of Flowering Plants

Data richness of flowering plants (Angiospermae) contained in Bandungan area consists of cultivated plants and wild plants. The identification results obtained as many as 61 species, 58 genera and 29 families. Flowering plants including monocots class contains 10 species and 5 families, while the dicots class found as many as 51 species and 24 families. Asteraceae was dominant family on study area which is 26.22%. The dominant class in study area was dicots with a percentage of 83.60%. Identification data of plant species presented in Table1.

Table 1. Flowering Plant Species of Bandungan Area

No.	Name of Family/Species	Uses/Nature
	MONOCOTYLEDONEAE	
	Cannaceae	
1	Bunga tasbih *(Canna indica)*	Ornamental plants; food; medicine; pesticide
2	Kana kuning (*Canna generalis*)	Ornamental plants
	Iridaceae	
3	Iris kuning *(Trimezia martinicensis)*	Ornamental plants; medicine
4	Iris putih *(Neomarica gracilis)*	Ornamental plants
	Amaryllidaceae	
5	Kembang coklat *(Zephyranthes candida)*	Ornamental plants; medicine
6	Sedap malam *(Polianthes tuberosa)*	Ornamental plants; medicine; perfume ingredients
	Commelinaceae	
7	Nanas kerang *(Tradescantia spathacea)*	Ornamental plants; drug; tea materials; anti-oxidants
8	Aur-aur *(Commelina diffusa)*	weeds; food; medicine
	Poaceae	
9	Rumput paetan (Axonopus compressus)	Ornamental, weed, medicine; animal feed
10	Bambu kuning hias *(Bambusa vulgaris)*	Ornamental plants; medicine; anti-bacterial; construction
	DICOTYLEDONEAE	
	Amaranthaceae	
11	Ekor kucing *(Celosia argantea)*	Ornamental plants; medicine; anti-inflammatory
12	Jengger ayam *(Celosia cristata)*	Ornamental plants; food; medicine
13	Bunga kenop (*Gomphrena globosa*)	Ornamental plants; tea materials; medicine
	Asteraceae	
14	Kenikir kuning *(Cosmos sulphureus)*	Ornamental plants; medicine; natural dyes; pesticide
15	Kenikir hias *(Cosmos bipinnatus)*	Ornamental plants; anti-oxidants
16	Bunga matahari *(Helianthus annuus)*	Ornamental plants; food; hyperaccumulator
17	Kembang kertas *(Zinnia elegans)*	Ornamental plants; anti-fungal; hyperaccumulator
18	Tembelekan *(Tagetes patula)*	Ornamental plants; pesticide; anti-fungal; anti-worm
19	Herbras *(Gerbera jamesonii)*	Ornamental plants; air pollution absorbers
20	Dahlia *(Dahlia pinnata)*	Ornamental plants; food; medicine
21	Krisan *(Chrysanthemum morifolium)*	Ornamental plants; air pollution absorbers

22	Ketul *(Bidens alba)*	weeds; medicine; antioxidants
23	Sintrong *(Crassocephalum crepidioides)*	weeds; food; medicine; anti-inflammatory
24	Bandotan *(Ageratum conyzoides)*	weeds; medicine; antioxidants; anti-inflammatory
25	Kirinyuh *(Eupatorium japonicum)*	weeds; medicine; antioxidants; anti-inflammatory
26	Legetan *(Acmella paniculata)*	weeds; medicine
27	Galinsoga *(Galinsoga quadriradiata)*	weeds; antioxidants; anti-UV
28	Paitan *(Tithonia diversifolia)*	weeds; pesticide; fertilizer; hyperaccumulator
29	Tempuh wiyang *(Emilia sonchifolia)*	weeds; food; medicine; anti-toxins, antibiotics
30	Daisi meksiko *(Erigeron karvinskiamus)*	Ornamental plants; weeds; antioxidants
	Linderniaceae	
31	Toreni *(Torenia fournieri)*	Ornamental plants
	Cleomaceae	
32	Laba-laba *(Tarenaya hassleriana)*	Ornamental plants
	Turneraceae	
33	Bunga pukul delapan *(Turnera subulata)*	Ornamental plants; medicine
	Hydrangeaeceae	
34	Panca warna *(Hydrangea macrophylla)*	Ornamental plants; drug; tea material; anti-diabetic
	Rubiaceae	
35	Bunga bintang (*Pentas lanceolata*)	Ornamental plants
36	Goletrak beuti *(Richardia brasiliensis)*	weeds; vomiting stimulant
	Begoniaceae	
37	Begonia lilin *(Begonia semperflorens)*	Ornamental plants
	Apocynaceae	
38	Tapak dara *(Catharanthus roseus)*	Ornamental plants; drug; anti-oxidants; anti cancer
	Fabaceae	
39	Kacang pintoi *(Arachis pintoi)*	Ornamental plants; nitrogen fixator
40	Putri malu *(Mimosa pudica)*	weeds; drug
41	Kembang telang *(Centrosema virginianum)*	weeds; nitrogen fixator; animal feed
42	Kaliandra *(Calliandra houstoniana)*	Animal feed; nitrogen fixator; firewood
	Verbenaceae	
43	Puyengan *(Lantana camara)*	Ornamental plants; drug; anti-oxidants
44	Pecut kuda *(Stachytarpheta jamaicensis)*	weeds; drug; anti-bacterial; anti-fungal
	Malvaceae	
45	Sidaguri *(Sida rhombifolia)*	weeds; drug
	Oxalidaceae	
46	Calincing *(Oxalis barrelieri)*	weeds; drug
47	Semanggi gunung *(Oxalis corniculata)*	weeds; food; drug
	Lamiaceae	
48	Jawer kotok *(Plectranthus scutellarioides)*	Ornamental plants; drug
49	Kemangi liar *(Clinopodium vulgare)*	weeds; drug
	Apiaceae	
50	Pegagan *(Centella asiatica)*	weeds; food; drug; anti-bacterial; anti-oxidants
	Polygoneceae	

51	Lady's thumb *(Persicaria longiseta)*	weed
	Euphorbiaceae	
52	Patikan emas *(Euphorbia heterophylla)*	weeds; poisonous
	Solanaceae	
53	Nandina *(Nicandra physalodes)*	weeds; drug; insecticide
54	Petunia *(Petunia hybrida)*	Ornamental plants
	Acanthaceae	
55	Ruelia ungu *(Ruellia simplex)*	Ornamental plants
56	Water willow *(Justicia procumbens)*	weeds; drug; anti-bacterial
	Polygaceae	
57	Akar wangi *(Polygala paniculata)*	weeds; perfume ingredients; antioxidants; anti-inflammatory
	Balsaminaceae	
58	Pacar air gunung *(Impatiens walleriana)*	Ornamental plants; anti-inflammatory
	Caryophyllaceae	
59	Bunga pink cina *(Dianthus chinensis)*	Ornamental plants; drug; anti-inflammatory
	Campanulaceae	
60	Bunga balon *(Platycodon grandiflorus)*	Ornamental plants; food; tea material; drug
	Rosaceae	
61	Mawar *(Rosa chinensis)*	Ornamental plants; perfume ingredients; drug

Asteraceae is the dominant family of research results with a total of 16 species. The Asteraceae family generally acts as an ornamental plant and cut flower. One of the most popular species of the Asteraceae family in the Bandungan area is chrysanthemum flowers (*Chrysanthemum morifolium*). Chrysanthemum is suitable for growing at an altitude of 700-1200 masl (Balai Penelitian Tanaman Hias, 2008), which is owned by the Bandungan Region. Chrysanthemum varieties that were identified and discovered during data collection were '*Puspita Kencana'*, '*Tirta Ayuni*', and '*Wastu Kaniya'* varieties. Asteraceae is the largest family of vascular plants, with a total of more than 23,600 species or about 8% of the total number of all plant species in the world (Jeffrey & Kadereit, 2007; Salamah et al., 2018).

Differences in altitude influence the types of plants that live in an area. The measurement results of abiotic factors indicate that the location of data collection has a height of around 955-1122 meters above sea level (masl), which at the height of the plant species richness in the highest range. Study about patterns of the altitude of the plant species richness concluded that the higher the region, the richness of plant species has increased and reached the highest at point 1000 masl, then decreased the species richness started at point an altitude of about 1400 masl (Grau et al., 2011; Grytnes & Vetaas, 2002; Ahmad et al., 2018).

Catalog Validity based on Experts Assessment (Material and Media)

Catalog validation is a process conducted by experts to assess the feasibility of the product before being used in trial phase. Prasetiyo & Perwiraningtyas (2016) explains that validation aims to control the content of the material in keeping with the needs and characteristics of the user. The assessment results by material expert and media expert are presented in Table 2.

Table 2. Validation Results by Material Expert and Media Expert

No.	Component	Percentage (%)	Criteria
1.	matter experts		
	Feasibility of content	85.41	very valid
	Feasibility of presentation		
2.	media expert		
	Feasibility of graphical	92.04	very valid
	Feasibility of language		
	Average	88.72	very valid

Data shows that the catalog validity is in the 'very valid' criteria, which means it can be used for the next stage with some improvements. Developed catalog display presented in Figure 1.

Figure 1. Display of catalogs' cover and content

The development process of supplementary teaching materials resulting a "Flowering Plants Catalog of Bandungan Area" in the form of printed books. The catalog component includes the introduction, the contents section, and the closing section. The introduction contains covers, previews, usage instructions, and introductory material. The contents section contains descriptions of flowering plant species which are equipped with photos and information. Meanwhile, the closing section contains attributes of identification, glossary, and bibliography. Overall this component has been assessed and confirmed by experts that it is feasible to be used as intended.

Effectiveness of Catalog based on Students Cognitive Learning Outcomes

Catalog effectiveness obtained from data cognitive achievement of students through the pretest and posttest. Test was conducted on 40 students and the data were analyzed using N-gain. Analysis data of students' cognitive learning outcomes presented in Table 3.

Table 3. Students' Cognitive Learning Outcomes

No.	Data	Value	N-gain	Criteria
1.	Class X IPA 1 (19 students)			
	average of pre-test	38.16	0.53	medium
	average of post-test	64.05		
2.	Class X IPA 2 (21 students)			
	average of pre-test	38.42	0.57	medium
	average of post-test	73.33		

N-gain calculations yield a slightly different number between the two classes, both of which are in the 'medium' criteria. The numbers shows there is an increase in learning outcomes between before and after conducting learning activities with 'medium' criteria. It can be interpreted that catalog effective to be used as supplement in plantae teaching materials. The same results in 'medium' N-gain criteria was yielded in the study of Afifah et al. (2018), regarding the development of E-module plantae material. Minimal completeness criteria used and defined in the school fot biology subject is 68.

N-gain is the difference between the value of the pre-test and post-test which indicates an increase of students' understanding or concepts mastery. Media can be considered as effective if it can improve the activity and learning outcomes (Sari & Susanti, 2016). Flowering Plants Catalog is effective in increasing understanding because it presents examples of flowering plants from the surrounding environment that students have not yet gotten in textbooks, so they can provide contextual insight. Contextual material can increase interest, motivation, and encourage students to apply knowledge (Nurinda et al., 2018; Zulfah & Aznam, 2017), thus impacting on improving learning outcomes. Giving catalogs in learning stimulates student activities in reading, observing, analyzing, comparing, and grouping, thereby increasing students' understanding.

The calculation results of the average of students' N-gain value between before and after learning using Flowering Plant Catalog shows that there is an increase in the pre and post-test values presented in Figure 2.

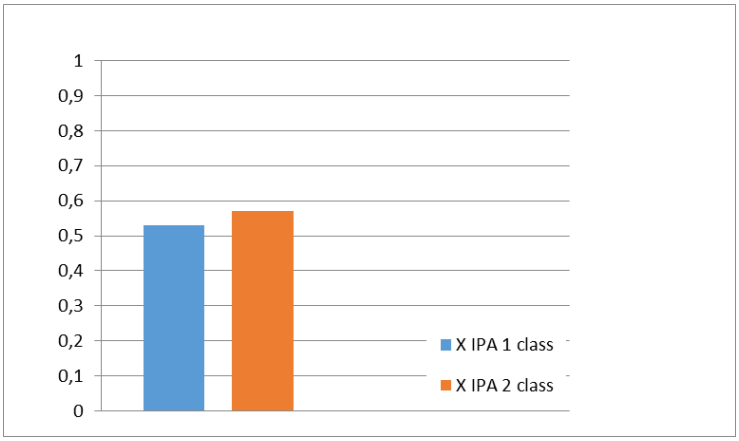

Figure 2. The average of Students' N-Gain values

The definition of effectiveness varies depending on what indicators to be achieved from the product development. Yuliati (2013) states that, integrated science teaching materials can be considered effective if it can improve the ability of high-level thinking skill. Flowering Plants Catalog in this case, can be said to be effective because it can improve the cognitive

achievement of students before and after the learning process. In line with the study that conducted by Lepiyanto & Pratama (2015), that the development of teaching materials based on the contextual environment tends to increase students' understanding of the biology subject.

Catalog Feasibility based on User Response (Students and Teachers)

User response consisting of 40 students and one teacher used to determine the feasibility of catalog to be used as teaching materials. The results of analyzing the response of students and teachers are presented in Table 4.

Table 4. Students and Teachers Response towards the Catalog

No.	User	Percentage (%)	Criteria
1	Student	84.18	very worthy
2	Teacher	92.04	very worthy
	Average	88.11	very worthy

The results of questionnaire analysis of teachers and students showed a positive response towards the catalog. Response includes the catalog display and implementation of learning process using catalog. The average responses qualifies as a 'very worthy'. Based on the results of the questionnaire analysis, it can be said that the catalog is very viable to be used in learning process.

Catalog as supplementary teaching materials considered particularly suitable for use in assisting existing books because the information presented is not overlapping but complementary. Textbooks in schools put more emphasis on the concept of matter, but lack of examples and presented the quality of the images was low, so the use of the catalog as a supplement teaching materials is a viable alternative to enrich learning resources because it presents a lot of images with an attractive appearance.

The interesting display of catalog can increase students' interest and motivation in learning which can ultimately improve learning outcomes. Visual media have a positive influence on students' motivation and attention to learning activities and provide direct experience effects on the object that being studied (Sabiralyani et al., 2015).

Supplementary book is a book that used to accompany the main book (Kurniasari et al., 2014). Setyanto et al. (2016) also explained that supplementary book have characteristics not integrated directly with the learning objects, but have the purpose of strengthening concepts in the learning objectives to be achieved.

The use of biology supplements materials tend to increase students' cognitive learning outcomes in terms of value before and after the learning process (Suniah et al., 2018), as well as in terms of completeness minimum criteria. Biological learning should be contextual and connected to the student environment so that students are able to understand material meaningfully (Chamany et al., 2008; Widodo et al., 2017). Supplementary teaching materials developed based on environmental potential can provide contextual insights and real experiences for students (Rahmatih et al., 2017). Contextual learning connects learning material to everyday life can increase motivation and encourage students to apply knowledge (Nurinda et al., 2018; Zulfah & Aznam, 2017).

Flowering Plant Catalog as a supplement to teaching materials can improve students' cognitive, insight, and motivation in learning plantae material. This research produces products that can be used as a companion to existing teaching materials, and contribute ideas and references for teachers or researchers who will develop similar products.

CONCLUSION

Based on the results of the study, it can be concluded that the flowering plants catalog found in the Bandungan area of Semarang is valid, proven effective in improving learning outcomes, and getting a positive response from users, namely sttudents and teacher.

REFERENCES

Afifah, D.I., Rahayu, E.S., & Anggraito, Y.U. (2018). Development of E-Module Based Android for Teaching Material of Plantae Kingdom Topic. *Journal of Biology Education*, 7 (1), 1-8.

Ahmad, M., Uniyal, S.K., & Singh, R.D. (2018). Patterns of Alien Plant Species Richness Across Gradients of Altitude: Analysis From the Himalayan state of Himachal Pradesh. *Tropical Ecology,* 59 (1), 35-43.

Balai Penelitian Tanaman Hias. (2008). Varietas Krisan. Bogor: Balitbang Pertanian & Kementrian Pertanian.

Chamany, K., Allen, D., & Tanner, K. (2008). Making Biology Learning Relevant to Students: Integrating People, History, and Context into College Biology Teaching. *Life Sciences Education*, 7, 267-278.

Data Strategis Kabupaten Semarang. (2015). Semarang: Kerjasama BAPPEDA Kabupaten Semarang dan BPS Kabupaten Semarang.

Grau, O., Ninot, J.M., Font, X., Ferré, A., & Grytnes, J.A. (2011). Trends in Altitudinal Distribution of Plant Diversity in the Catalan Pyrenees. *Internacional de Botànica Pirenaico-cantàbrica a Ordino, Andorra*, 9, 171-180.

Grytnes, J.A. & Vetaas, O.R. (2002). Species Richness and Altitude: A Comparison between Null Models and Interpolated Plant Species Richness along the Himalayan Altitudinal Gradient, Nepal. *The American Naturalist,* 159 (3), 294-304.

Husna, D.N., Ngabekti, S., & Abdullah, M. (2018). The Development of Pteridophyte Catalog of Curug Lawe Petungkriyono as Learning Source for Senior High School Students. *Journal of Biology Education*, 7 (1), 82-90.

Jeffrey, C. & Kadereit, J.W. (2007). Families and Genera of Vascular Plants. *Flowering Plants, Eudicots, Asterales*. Berlin: Springer.

Kurniasari, D.A.D., Rusilowati, A., & Subekti, N. (2014). Pengembangan Buku Suplemen IPA Terpadu dengan Tema Pendengaran Kelas VIII. *Jurnal Pendidikan IPA Indonesia,* 3 (2), 462-467.

Nurinda, S., Sajidan, & Prayitno, B.A. (2018). Effectiveness of Problem-Based Learning Module as An Instructional Tool in Improving Scientific Argumentation Skill. *Biosaintifika,* 10 (2), 334-340.

Lepiyanto, A. & Pratiwi, D. (2015). Pengembangan Bahan Ajar Berbasis Kontekstual pada Mata Kuliah Biologi Umum. *Jurnal Pendidikan Biologi*, 6 (1), 2-29.

Prasetiyo, N.A. & Perwiraningtyas, P. (2016). Pengembangan Buku Ajar Berbasis Lingkungan Hidup pada Matakuliah Biologi di Universitas Tribhuwana Tunggadewi. *Jurnal Pendidikan Biologi Indonesia*, 3 (1), 19-27.

Rahmatih, A.N., Yuniastuti, A., & Susanti, R. (2017). Pengembangan Booklet Berdasarkan Kajian Potensi dan Masalah Lokal Sebagai Suplemen Bahan Ajar SMK Pertanian. *Journal of Inovative Science Education*, 6 (2), 162-169.

Salamah, A., Oktarina, R., Ambarwati, E.A., Putri, D.F., Dwiranti, A., & Andayani, N. (2018). Chromosome Numbers of Some Asteraceae Species from Universitas Indonesia Campus, Depok, Indonesia. *Biodiversitas*, 19 (6), 2079-2087.

Sari, L.Y. & Susanti, D. (2016). Effectiveness Test of Learning Media Interactive Oriented Construktivism in Neurulasi Topic to Animal Development Subject. *BioCONCETTA*, 2 (1), 158-164.

Setyanto, H.A., Amin, M., & Lestari, U. (2016). Pengembangan Buku Suplemen Pendekatan Molekuler Taksonomi Hewan Vertebrata. *Jurnal Pendidikan*, 1 (6), 1180-1184.

Shabiralyani, G., Hasan, K.S., Hamad, N., & Iqbal, N. (2015). Impact of Visual Aids in Enhancing the Learning Process Case Research: District Dera Ghazi Khan. *Journal of Education and Practice*. 6 (19), 226-234.

Suniah, Indriyanti, D.R., & Dewi, N.K. (2018). Booklet Development Based Research on the Diversity of Insects on Solanaceae as a Suplement of Biology Teaching Materials in High School. *Journal of Innovative Science Education*, 7 (2), 176-183.

Widalismana, M., Baedhowi, & Sawiji, H. (2016). Pengembangan Media Pembelajaran Berbasis Katalog untuk Meningkatkan Hasil Belajar Siswa pada Mata Pelajaran Ekonomi di SMA Negeri 5 Surakarta. *Jurnal FKIP*, 1 (2).

Widodo, A., Maria, R.A., & Fitriani, A. (2017). Constructivist Learning Environment During Virtual and Real Laboratory Activities. *Biosaintifika*, 9 (1), 11-18.

Yuliati, L. (2013). Efektivitas Bahan Ajar IPA Terpadu terhadap Kemampuan Berpikir Tingkat Tinggi Siswa SMP. *Jurnal Pendidikan Fisika Indonesia*, 9, 53-57.

Zulfah, H. & Aznam, N. (2018). Development of Natural Sciences Module with Reflective Learning Journal to Enhance Student's Reporting-Interpretative Skills. *Biosaintifika*, 10 (2),362-368.