



UNESA  
Universitas Negeri Surabaya

# SERTIFIKAT

No : 075/PAN-SNF/X/2019

Diberikan Kepada :

**Dr. Titin Sunarti, M.Si.**

Sebagai Pemakalah dengan Judul :

**“Multidisciplinary, Interdisciplinary, and Transdisciplinary Approaches in Literacy Learning Model”**

dalam Seminar Nasional Fisika 2019 dengan tema:

**“Inovasi Fisika dan Aplikasinya di Era Revolusi Industri 4.0”**

Diselenggarakan oleh Jurusan Fisika FMIPA Unesa pada tanggal 19 Oktober 2019



Dekan FMIPA

Prof. Dr. Madlazim, M. Si.  
NIP 196511051991031012



Ketua Panitia

Dr. Titin Sunarti, M. Si.  
NIP 196311271987032001



PAPER • OPEN ACCESS

## Multidisciplinary, Interdisciplinary, and Transdisciplinary Approaches in Literacy Learning Model

To cite this article: T Sunarti *et al* 2020 *J. Phys.: Conf. Ser.* **1491** 012054

View the [article online](#) for updates and enhancements.



**IOP | ebooks™**

Bringing together innovative digital publishing with leading authors from the global scientific community.

Start exploring the collection—download the first chapter of every title for free.

# Multidisciplinary, Interdisciplinary, and Transdisciplinary Approaches in Literacy Learning Model

T Sunarti<sup>1\*</sup>, W Wasis<sup>1</sup>, M Madlazin<sup>1</sup>, and S Suyidno<sup>2</sup>

<sup>1</sup>Department of Physics, FMIPA Universitas Negeri Surabaya, Indonesia.

<sup>2</sup>Department of Physics Education, FKIP Universitas Lambung Mangkurat, Indonesia.

\*E- mail: titinsunarti@unesa.ac.id

**Abstract.** A multidisciplinary, interdisciplinary, and transdisciplinary approach has an important contribution to designing a quality model. The purpose of this study is to determine the feasibility of the Literacy Learning Model (LLM) based on a review of multidisciplinary, interdisciplinary, and transdisciplinary approaches. The research included a meta-analysis study through a review of 23 previous articles relating to the contribution of physics, educational psychology, and technology in LLM design. Data collected is done by reduction, identifying variable, mind map, exposure, and conclusion. The results showed that physics, educational psychology, and technology; also multidisciplinary, interdisciplinary, and transdisciplinary approaches have contributed to the LLM design. This has made the feasibility of LLM as an innovative learning design to train literacy learning planning for pre-service physics students.

## 1. Introduction

In the industrial era 4.0, the problems of various human lives including in the world of education in Indonesia are increasingly complex and diverse [1-5]. This problem is no longer able to be overcome only by using a monodisciplinary approach, but a multidisciplinary, interdisciplinary, and even multidisciplinary approach is needed to find the best solution [6,7]. The reality, the world of education today, including in Indonesia, still teaches separate disciplines [8]. This makes physics less attractive and difficult to learn [5,9]. Therefore, the development of scientific literacy as an activity of human life and its problems needs to be trained comprehensively and systematically for prospective physics teacher students in the class [10].

The development of students' scientific literacy in learning physics can be effective and efficient when taught according to the nature of science itself, namely science as a product, process, attitude, and value [11]. Students are involved in behaving and proceeding in searching and finding their science products [3,12]. Students also internalize good values in interacting with others and their environment [13]. Meanwhile, the success of science learning objectives is also influenced by the readiness of teachers in planning appropriate learning. Careful planning includes established rules or objectives and emphasizes responsible, efficient, practical and systematic behavior [14].

Science learning planning involves certain scientific concepts, laws, and theories to explain various natural phenomena, encouraging new experiments to uncover the secrets of nature, requires creativity and tenacity in transforming physical content into its application in real life [15,16]. By understanding scientific literacy, students can provide solutions rationally and easily understood, support the open



mind, objective and fair thinking, supports critical and creative thinking about assumptions, ideas, testing and interpretation [17,18].

Science literacy learning planning is related to the readiness of scientific material and conducive psychological and psychological conditions. Lecturers must equip prospective pre-service physics teachers with teacher competencies, namely professional, pedagogical, social, and personality competencies [19,20]. Lecturers need to build close relationships with their students and build a caring environment that is affectionate for their personal development; interested in learning, master academic material and be able to transfer material effectively; and integrating technology into its teaching repertoire to improve the meaningfulness of learning [8,14]. This plan includes formulating learning goals, allocating time, choosing appropriate materials and methods, selecting learning resources, creating learning interest, building a productive learning environment, and evaluating learning [14,21]. Thus, prospective pre-service physics teacher is not only equipped with positive attitudes towards science and scientific literacy abilities. But also, they need to be equipped with the ability to plan learning science literacy well [13,16].

Planning scientific learning literacy can use innovative learning models that are appropriate to the characteristics of the material and students. A quality learning model has an interdisciplinary, multidisciplinary, and transdisciplinary review in its development [22, 23]. This approach is seen as an intellectual space where the scientific issues studied are interrelated, expounded, and opened to gain a better understanding [8]. One of the innovative learning designs that have been developed to practice science literacy skills and its learning is the Literacy Learning Model (LLM) [13,16]. LLM as an improvement of guided inquiry learning, problem-based learning, CPI learning is considered feasible to facilitate the positive attitude of prospective physics teacher students in constructing scientific literacy skills and producing and implementing science literacy learning [24]. The feasibility of LLM has not been reviewed from a multidisciplinary, interdisciplinary, and multidisciplinary approach. Therefore, the purpose of this study is to determine the feasibility of LLM based on multidisciplinary, interdisciplinary, and transdisciplinary reviews.

## **2. Method**

### *2.1 Background Research*

The study was conducted at the Department of Physics, Surabaya State University, Indonesia. The method used in this research is meta-analysis, which is conducted a review of 12 previous research articles to explore the feasibility of the Literacy Learning Model (LLM) based on multidisciplinary, interdisciplinary, and transdisciplinary reviews. Interdisciplinary is interpreted as intensive interaction between disciplines so that it results in the integration of data, methods, tools, concepts, and theories and sometimes creates new methods, concepts or theories; multidiscipline is the involvement of several scientific disciplines and the results are still formulated from the perspective of scientific disciplines; while transdisciplinary is the integration of academic knowledge from various disciplines and non-academic knowledge [23]. The use of transdisciplinary in LLM is expected to be able to create the views needed to explore new meanings and a synergy [8,22].

### *2.2 Research Samples*

The subjects of this study were previous research articles on the ability of scientific literacy. The criteria for selecting articles are: (1) including the work of previous researchers; (2) the results of research publications in the last six years, i.e. publications from 2014 to 2019; and (3) focus on scientific literacy and learning. Based on the above criteria; then selected 23 research articles are presented in Table 1.

**Table 1.** Results of the research article search.

Article	Title & Year	References
1	Development of student activity and supporting media for teaching materials to practice science process skills (2014)	[25]
2	Development of student activity sheets and inquiry learning media based on critical thinking skills (2014)	[26]
3	The application of inquiry learning model to the material of optical devices to improve the students' critical thinking skills of in grade at 1st Junior High School Sidoarjo (2015)	[27]
4	Development of science learning tools the topic of pressure on guided inquiry-oriented liquids to train science process skills and conceptual understanding of junior high school students (2016)	[28]
5	The application of the inquiry learning model to improve "Satu Atap" students' learning results at 1 st Junior High School Singosari Malang (2016)	[29]
6	Development of scientific literacy tests on heat material at 5th Senior High School Surabaya (2017)	[10]
7	The improvement of students' scientific literacy through guided inquiry learning models on fluid dynamics topics (2017)	[4]
8	Application of guided inquiry learning models to improve students' scientific literacy skills on the material elasticity at 1st senior high school Plemah Kediri (2017)	[5]
9	Application of guided inquiry learning model to improve the ability of inquiry and student learning outcomes in class 10 on the subject matter of static fluid in the High School 1 Driyorejo Gresik (2017)	[30]
10	Efforts to improve the ability of scientific literacy with guided inquiry learning models in Senior High School for optical instrument materials (2018)	[31]
11	Application of guided inquiry learning models to improve science process skills in Newton's law material about motion at 1st Senior High School Gedangan (2018)	[32]
12	Application of the guided inquiry learning model to improve the students' scientific literacy skills of High School (2018)	[9]
13	Application of guided inquiry learning models to improve students' science process skills in static fluid material at Senior High School Mojoagung (2018)	[33]
14	Developing worksheets to civilize scientific literacy for students of physics teacher candidates (2018)	[18]
15	Implementation of community technology science learning models to improve science literacy in physics learning (2018)	[34]
16	The effectiveness of the CPI model to improve positive attitude toward science (PATS) for pre-service physics teacher (2018)	[13]
17	Effectiveness of CPI (construction, production, and implementation) teaching model to improve science literation for pre-service physics Teacher) (2018)	[16]
18	The implementation of the guided inquiry model to practice problem-solving skills at 1 st senior high school (2018)	[35]
19	Feasibility of learner autonomy oriented physics learning material to train student's science process skills (2019)	[36]
20	The Effectiveness of problem-based learning in improving students' scientific literacy skills and scientific attitudes (2019)	[37]
21	Exploration of the dimensions of student creativity through the integration of scientific knowledge, science technology, engineering, and mathematics (2019)	[38]
22	The implementation of problem-based learning with gallery walk strategy on global warming (2019)	[39]
23	Effectiveness of literacy learning model to improve skills of scientific literacy learning plan for physics teacher candidates (2019)	[40]

### 2.3 Data Analysis

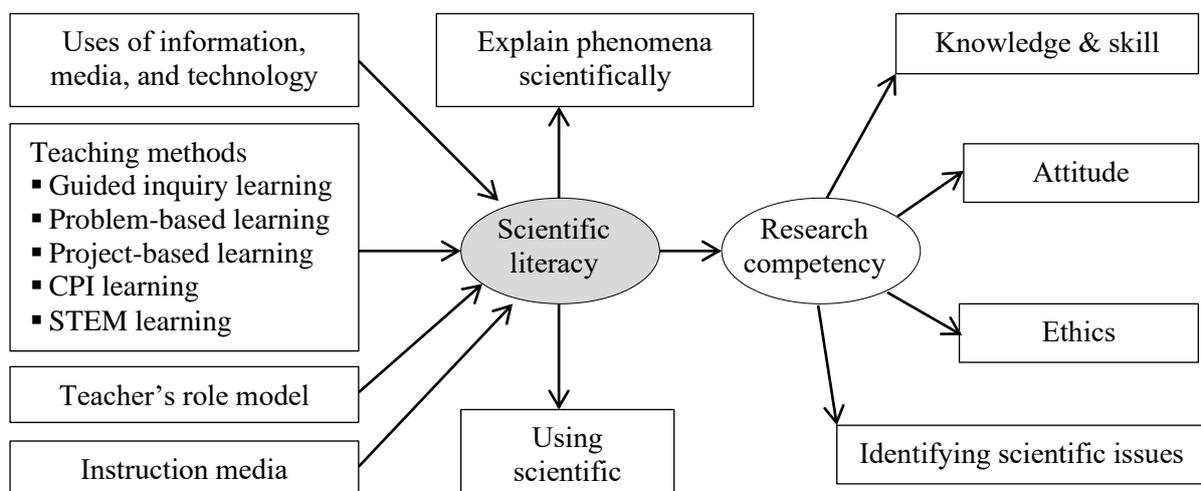
The data analysis technique was done in descriptive qualitative. The analysis begins with identifying the independent variables, the dependent variable, and the research findings of the 23 selected articles, data reduction and mapping between variables are carried out. Then, it presentations based on multidisciplinary, interdisciplinary, and transdisciplinary reviews in LLM, the end with a conclusion.

### 3. Results and Discussion

The results of identifying independent variables, dependent variables, and research findings are presented in Table 2.

**Table 2.** Results of the identification of research articles.

Article	Independent Variable	Dependent variable	Finding
6	Science literacy assessment	Science literacy	The design of scientific literacy tests can measure the ability to explain phenomena scientifically, evaluate and design scientific investigations, and interpret data and evidence scientifically
1-5 ,7-13,18	Guided inquiry learning	Process skill, problem-solving, science literacy	Guided inquiry learning can improve science processes, problem-solving, and students' scientific literacy abilities
14	Science literacy worksheet	Science literacy	Science inquiry activities and their applications in problem-solving, technology products, and decision making can be used to practice scientific literacy
15,21	STEM Learning	Science literacy	Learning Science Technology Society can improve students' scientific literacy
19,20,22	PBL	Science process skill, scientific literacy, attitude toward science	Problem-based learning can improve science processes skill, scientific literacy skill, and students' positive attitude toward science
16,17, 23	LLM/CPI model	Positive attitude toward science and science literacy	As an improvement of PBL, the CPI model is effective for improving positive attitude toward science and science literacy for pre-service physics teachers



**Figure 1.** Causal model for developing scientific literacy [Adapted 30].

Based on Figure 1, The development of students' scientific literacy skills involves aspects of knowledge and skills, attitudes, and values. Students are expected to have cognitive development before starting to develop their students' scientific literacy abilities and become role models for their students in the future. An appropriate lecturer educator as a key mechanism for directing the development of students' scientific literacy through the process of learning in class. This is supported by previous research [41] that the key factors in the development of student scientific literacy include the use of ICT, the teaching model of lecturers, the selection of methods and learning media that promote science literacy to students. Also, students need to have the ability to research information and verify the credibility of information sources. Thus, students not only master the ability of scientific literacy (knowledge, skills, attitudes, values) but also learning planning. However, the use of guided inquiry learning, project-based learning, problem-based learning, STEM learning is only effective for training students' scientific literacy skills [1-5,7-13,15,18-22]. Therefore; The CPI Model is deliberately designed to equip prospective physics teacher students with scientific literacy skills and learning planning [13,16]. The CPI model was later refined to Literacy Learning Model (LLM) [40].

### *3.1 Multidisciplinary and Interdisciplinary Review in LLM*

Based on Figure 1, Multidisciplinary and interdisciplinary reviews can be seen in the contribution of the fields of science-physics, educational psychology, and technology in the development of scientific literacy. The contribution of science in LLM is the design of student activities in each phase of LLM by the nature of physics (products, processes, attitudes, and values). Learning physics develops the ability to design, test, and modify qualitative explanations or quantitative relationships, design scientific investigations to develop new concepts, test concepts and apply them in practical problem solving, collect and analyze data, evaluate the results of experiments and find solutions to problems, and scientific communication [42]. The application of LLM has had a significant impact on increasing positive attitudes towards science, scientific literacy skills, and planning skills in learning scientific literacy in prospective physics teacher students [16,18,24,40].

Contributions in the field of Educational Psychology in LLM can be seen from the design of learning activities or in the process of student interaction with others and the learning environment. The field of educational psychology provides an important contribution in building positive interactions between the behavior of lecturers and students, students and students as well as the learning environment to achieve the specified physics learning goals. This LLM activity is supported by constructivism theory, metacognition skills, reciprocal relationship models, complex cognitive processes, advanced organizers, and scaffolding. Through LLM, lecturers establish positive interactions with students by motivating and appreciating each student's positive responses and attitudes towards science (phase 1), the lecturer facilitates and motivates students in constructing scientific literacy (phase 2), appreciate the performance of students in studying and evaluating PPLS Examples, developing PPLS, carrying out simulations or peer teaching, and revising PPLS (phase 3), then appreciate each student's opinions and suggestions in evaluation and reflection (phase 4) [16,18,21,24,40]. This is following the theory of social learning by Vygotsky [21] that social interaction encourages students to construct knowledge and develop skills. Lecturers inspire students to be motivated to study physics by making them more enthusiastic in discussing physics material, solving problems, reading physics lessons, and feeling learning physics influences their career prospects in the future. Lecturers assure students that they can learn and new ideas in physic, can plan and carry out experiments well and can make conclusions based on experimental data or reference studies. Thus, the fields of educational psychology and physics are mutually integrated and underlie the activities of lecturers and students in learning physics well and beneficially.

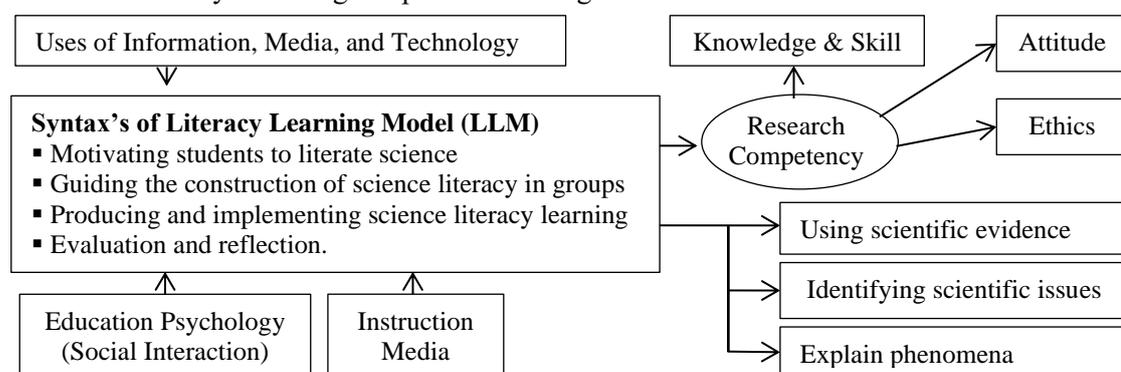
The contribution of technology in LLM is the use of information and technology media as the main support system for LLM. LLM requires a support system including laboratory equipment or learning media so that technology has a contribution in providing appropriate and quality support systems [16,18,24,40]. Lecturers can facilitate the availability of technology in the form of laboratory equipment, learning media, and other supporting equipment (laptops, LCDs, digital references, etc.) in supporting

the construction of scientific literacy through scientific investigation, problem-solving, technology products, and retrieval. Lecturers inspire students to utilize technology products that support the production and implementation of learning scientific literacy in the classroom. Therefore, the learning environment created by LLM indirectly equips prospective physics teacher students with the ability to use information, media, and technology. It can be synthesized that a multidisciplinary and interdisciplinary review be seen from the contributions of each field of science, psychology, education, and technology to the development of science literacy. Therefore, LLM meets the eligibility criteria in terms of multidisciplinary and interdisciplinary approaches.

### 3.2 Transdisciplinary Review in LLM

The name LLM is chosen based on the words "Literacy" and "Learning". Literacy means competence or knowledge in a certain area [43]. Science literacy competencies for prospective physics teacher students include knowledge competencies and scientific literacy skills, attitudes and values (positive attitude towards science), and planning skills for scientific literacy learning [16-22,41,44]. Learning means changing knowledge or skills through study, experience, or teaching [43]. Thus, Literacy learning means the process of changing the knowledge and skills of scientific literacy, a positive attitude towards science, and the skill of planning science literacy learning. Literacy learning is operationalized in the form of lecturer activities that facilitate the construction process of scientific literacy and the production and implementation of science literacy learning.

Construction is defined as the method used to build something [43]. According to Vygotsky's constructivism [45] theory that students must actively build their knowledge through personal experience with others and the environment. Therefore, students can use a scientific approach (identification, exploration, explanation, application, and reflection) in building the ability of scientific literacy through personal experience with others and the environment. Production-Implementation, production is defined as the act of making components/the manufacturing process, and implementation as the process of determining the decision or plan [43]. This is supported by Bandura's theory that learning through observation involves attention, retention, production, and motivation. Also, Vygotsky's social constructivism theory (lecturers facilitate social interaction to encourage knowledge construction and skills development) and cognitive apprenticeship (the process of making students gradually gain intellectual skills through interaction with people who are more expert, adults, or smarter friends), and scaffolding (helping students overcome certain problems that are beyond their developmental capacity with the help of more capable friends or lecturers) [14,21,45]. Therefore, the production of learning tools through the identification of Examples of Science Literacy Learning Devices (PPLS), then discussions and consultations on the preparation of PPLS individually or in groups; continued implementation through peer teaching/simulation and discussing the results, and revision of PPLS. Thus, LLM is an innovative learning design to facilitate students' positive attitudes in constructing scientific literacy skills and producing and implementing science literacy learning. A transdisciplinary overview appears from the LLM syntax design as presented in Figure 2.



**Figure 2.** Causal Model Literacy Learning Model.

Based on Figure 2, LLM integrates the fields of physics (products, processes, attitudes, values), educational psychology (learning theories), and technology (laboratory equipment, learning media, laptops, LCDs, digital references, technology products, etc.) to support the success of science learning activities in each phase of LLM. The readiness of teaching materials and learning environments strongly supports the construction of student knowledge, and the existence of social interaction makes it easy for students to construct their knowledge and skills development [45]. This is consistent with previous research [3,46-48] that studying physics integrates the complexities of physics and technology on one side and responsibility to the community on the other. By studying physics, students can understand the impact of the latest science and technology, follow the latest science news or reports, and dare to make the right decisions and actively participate in public discourse regarding the latest science issues.

Based on the description above, it can be synthesized that a multidisciplinary, interdisciplinary, and transdisciplinary approach (involving: the fields of physics, educational psychology, technology) has contributed to the feasibility of LLM. Therefore, the fundamental implication of this research is that LLM can be used to equip professional, pedagogic, social, and personality competencies for prospective physics teacher students. Students are facilitated as students in constructing scientific literacy skills through the process of scientific inquiry, decision making, and solving real-life problems, then act as a teacher in planning and implementing science literacy learning well.

#### 4. Conclusion

The multidisciplinary and interdisciplinary application can be seen from the role of each field of physics, educational psychology, and technology in the development of scientific literacy and its learning. Furthermore, the integration of these three fields can produce LLM designs that facilitate the activities of lecturers and students in constructing scientific literacy capabilities (through scientific inquiry, problem-solving, technology products, and decision making), and the activities of producing and implementing science literacy learning through identifying PPLS examples, preparing PPLS, implementing through peer teaching, discussion and revision of PPLS. The adoption of a transdisciplinary approach in LLM makes this design more creative, original, and tested in practicing a positive attitude towards science, scientific literacy skills, and planning literacy learning skills for prospective physics teacher students. To strengthen the results of this study, further research is needed in the fields of science, biology, and chemistry.

#### References

- [1] Alfin J, Fuad A H, Nur M, Yuanita L and Prahani B K 2019 *Int. J. Inst.* **12** 147
- [2] Insani N F and Sunarti T 2018 *J. Inov. Pend. Fis.* **7** 149
- [3] Suyidno, Nur M, Yuanita L, Prahani B K and Jatmiko B 2018 *J. Baltic Sci. Educ.* **17** 136
- [4] Arifin L and Sunarti T 2017 *J. Pend. Fis. Apl.* **7** 68
- [5] Tamara A F and Sunarti T 2017 *J. Inov. Pend. Fis.* **6** 1
- [6] Didde R 2014 Challenges and successes in interdisciplinary and transdisciplinary research and education (Netherlands: WIMEK experiences)
- [7] Stok P and Burton R J F 2013 *Sustainability* **3** 1090.
- [8] Batmang 2016 *J. Al-Ta'dib* **9** 44
- [9] Shellawati S and Sunarti T, 2018 *J. Inov. Pend. Fis.* **7** 407
- [10] Rosidah F E and Sunarti T 2017 *J. Inov. Pend. Fis.* **6** 250
- [11] Boisandi and Darmawan H 2017 *J. Ilm. Pend. Fis. Al-BiRuNi* **6** 179
- [12] Suyidno, Dewantara D, Nur M and Yuanita L 2017 *Adv. Soc. Sci. Educ. Humanit. Res* **100** 98
- [13] Titin T, Wasis, Madlazim, Suyidno and Prahani B K 2018 *J. Phys: Conf. Ser.* **997** 012013
- [14] Arends R I 2012 *Learning to teach* (New York: Mc. Graw-Hill)
- [15] Walker J S 2014 *Physics: Fourth edition* (San Fransisco: Pearson Education)
- [16] Sunarti T, Prahani B K, Wasis, Madlazim and Suyidno 2018 *J. Sci. Educ.* **18** 73
- [17] Yilmaz Y O and Cazas B 2016 *J. Baltic Sci. Educ.* **15** 506

- [18] Sunarti T, Wasis and Madlazim 2017 *Proc. Int. Conf. Educ. Innov.* **1** 910
- [19] Eggen P D and Kauchak D P 2013 *Educational psychology: Windows on classrooms (9th edition)* (New Jersey: Pearson)
- [20] Loughran J 2014 *J. Teach. Educ.* **65** 1
- [21] Slavin R E 2011 *Educational psychology, theory and practice* (Boston: Pearson Education)
- [22] Lawrence R J 2011 *Trans. J. Eng. Sci.* **1** 125
- [23] Lawrence R J and Despres C 2004 *Introduction/Futures* **36** 397.
- [24] Sunarti T 2018 *Pengembangan Literacy Learning Model untuk Meningkatkan Kemampuan Merencanakan Pembelajaran Literasi Sains Mahasiswa Calon Guru* Dissertation (Surabaya: Pascasarjana Unesa).
- [25] Mahfuziannor, Suyidno and An'nur S 2014 *Berk. Ilm. Pendidik. Fis* **2** 78
- [26] Jayanti I B R, Suyidno and Hartini S S 2014 *Berk. Ilm. Pendidik. Fis* **2** 1
- [27] Prabowo L S B and Sunarti T 2015 *J. Inov. Pendidik. Fis.* **4** 6
- [28] Sari R N, Ibrahim M and Wasis 2016 *J. Pendidik. Sains Pascasarjana Unesa* **5** 1048
- [29] Setiawan B, Sunarti T and Astriani D 2016 *J. Pendidik. IPA Indonesia* **5** 45
- [30] Ambarwati D A and Sunarti T 2017 *J. Inov. Pendidik. Fis.* **6** 21
- [31] Dewi N A R and Sunarti T 2018 *J. Inov. Pendidik. Fis.* **7** 381
- [32] Putri M D and Sunarti T 2018 *J. Inov. Pendidik. Fis.* **7** 376
- [33] Safira Y W and Sunarti T 2018 *J. Inov. Pendidik. Fis.* **7** 452
- [34] Insani N F and Sunarti T 2018 *J. Inov. Pendidik. Fis.* **7** 149
- [35] Iffah N and Sunarti T 2019 *J. Inov. Pendidik. Fis.* **8** 623
- [36] Zakiati E, Mastuang and Suyidno 2019 *Berk. Ilm. Pend. Fis* **7** 105
- [37] Prastika M D, Wati M and Suyidno 2019 *Berk. Ilm. Pendidik. Fis* **7**
- [38] Susilowati E and Suyidno 2019 Eksplorasi Dimensi Kreativitas Siswa melalui Integrasi Pengetahuan Science Technology Engineering and Mathematics (STEM) *Prosiding Semnas Motogpe* (Banjarmasin: Universitas Lambung Mangkurat)
- [39] Septiana D A and Sunarti T 2019 *J. Inov. Pend. Fis.* **8** 692
- [40] Sunarti T 2019 *J. Phys: Conf. Ser.* **1171** 012004
- [41] Udompong L, Traiwicikhun D and Wongwanich S 2014 *Proc-Sos. Behav. Sci.* **116** 1581
- [42] Etkina E 2013 *Proc. Inter. Conf. Phys. Educ.* (Prague: Czech Republic) pp. 2
- [43] Oxford 2018 *English living dictionary* <https://en.Oxford.dictionaries.com/definition>
- [44] Liakopoulou M 2011 *Inter. J. Hum. Soc. Sci.* **1** 66
- [45] Moreno R 2010 *Educational psychology* (New Mexico: John Wiley & Sons, Inc)
- [46] Bilek M 2016 *J. Baltic Sci. Educ.* **15** 136
- [47] Demirel M and Caymaz B 2015 *Proc-Soc. Behav. Sci.* **191** 1903
- [48] Jimenez A M, Fernandez B G and Franco M T B 2016 *J. Baltic Sci. Educ.* **15** 371