Preliminary research in the development of physics teaching materials that integrate new literacy and disaster literacy

F Mufti¹, Asrizal¹, S A Hanum² and A Fadhilah².

¹Physics Department, Faculty of Mathematics and Science, Universitas Negeri Padang, Indonesia.
²Student in Physics Department, Faculty of Mathematics and Science, Universitas Negeri Padang, Indonesia.

*fatni_mufit@fmipa.unp.ac.id,

Abstract. 21st century learning plays an important role in producing quality human resources, in order to have global competitiveness. Among the competencies students must have is new literacy, as an extension of scientific literacy that has been proclaimed by the previous government. New literacy includes data literacy, technology literacy and human literacy. Besides that, students also need to have disaster literacy, because Indonesia is located in an area prone to disasters. This study aims to determine the scientific literacy (conceptual understanding) of students, and knowing the extent of integrating new literacy and disaster literacy into learning in schools. The type of research conducted is survey research. The instruments used were concept tests, learning observation sheets, interview guides for teachers, and textbook analysis sheets. The concept test was given to 78 class XI students from three different schools, and interviews were conducted with 3 physics teachers in the three schools. Book analysis was performed on 5 physics textbooks that are widely used in schools. Data are analyzed quantitatively and qualitatively. The results showed that learning in schools is still traditional or teacher-centered learning. The integration of new literacy and disaster literacy in the learning process and textbooks used is still low. Understanding of student concepts is also low and misconceptions occur. Therefore, the recommendation from this preliminary study is the need to develop physics teaching materials that integrate new literacy and disaster literacy, and can improve students' understanding of concepts according to the demands of the 21st century.

1. Introduction
Life in the 21st century demands various skills that a person must master. With this foundation education should be able to prepare students to master these various skills to become successful individuals in life. Literacy is one of the 21st century skills that has become a strategic issue in the world of education. In education, literacy is an important tool for students to recognize, understand, and apply the knowledge they have gained in learning. In addition, literacy also supports their success both in their daily lives at home and in the surrounding environment. For this reason, a variety of student literacy skills need to be developed in learning.

Literacy is needed to face the challenges of the industrial revolution 4.0. One of the movements launched by the government is the new literacy movement as an amplifier even shifting the old literacy movement. The literacy needed to deal with the industrial revolution 4.0 is known as new
literacy. New literacy is data, technology and human literacy ([11]. New literacy includes data literacy, technology literacy and human literacy [2,3].

Data literacy is directed at the aim of increasing the ability to read, analyze, and use information in the digital world. Technology literacy aims to provide an understanding of the workings of machinery and technology applications. On the other hand, human literacy is directed at improving communication skills and mastery of design science [4]. In other words, human literacy is related to communication skills, collaboration, critical thinking, creative and innovative. The new literacy provided is expected to create competitive graduates by perfecting the old literacy movement which only focuses on improving reading, writing and mathematics skills.

Another challenge for education in Indonesia is regional conditions. Indonesia is an archipelagic country that has a variety of forms on the face of the earth, both on land and on the seabed. This condition turned out to have a close relationship with human activities. Indonesia is a country that is very rich in resources, be it human or natural resources. This abundant natural wealth is used for the prosperity of all the people of Indonesia. Even though Indonesia is a rich and beautiful country, Indonesia's territory is prone to disasters. Geographically, Indonesia is an archipelago located at the confluence of four tectonic plates namely the Asian continental plate, the Australian continental plate, the Indian oceanic plate, and the Pacific oceanic plate. Therefore, with Indonesia's geographical position like this, Indonesia cannot avoid high potential disasters. There is a need for student and community awareness of disasters and the ability to avoid the risk of disasters, known as disaster management literacy.

Disaster literacy is defined as the ability of individuals to read, understand, and use information to make informed decisions and follow instructions in the context of mitigation, preparation, response and recovery from a disaster [5,6,7]. Another understanding of disaster literacy is part of a non-structural approach that focuses on one's knowledge of disasters. This literacy is useful for measuring and building the capacity of a person and society in a disaster [8]. Means that disaster literacy is related to one's ability needed in aspects of a disaster both before the disaster, at the time of the disaster, and after the disaster. Therefore, the purpose of this disaster literacy is an effort to provide understanding to students and the community about disasters so as to minimize the risk of disaster.

The study of natural phenomena including disasters, is part of physical science. Physics is an interesting science because physics learns about the workings of the world [9]. In the world often occur natural events such as earthquakes, tsunamis, flash floods, hurricanes, and so on. Physicists try to observe natural phenomena and try to find patterns and principles from these natural phenomena [10]. Besides that, physics has a big role in supporting science and technology, because Physics is a basic science in supporting the development of science and technology [11].

But the real conditions show that the literacy of Indonesian students is still low. There are at least three real conditions that indicate that Indonesian student literacy is low. The first real condition is the limited integration of literacy in learning. From the results of interviews with Physics teachers, it is known that literacy is cultivated in schools only by reading literacy. The second real condition is the low scientific literacy of Indonesian students. This condition is known from the literacy report from PISA [12,13]. The third real condition is the weakness of disaster literacy from students and the community. disaster literacy in Indonesia is very minimal, it seems that it is not yet cultured in writing lessons about disaster. The disaster literacy movement in Indonesia is still very weak. Even though the level of knowledge is very determining the ability to save themselves when a disaster occurs [14].

Weak literacy of students in learning cannot be allowed. The impact of weak literacy is the lack of students' ability to achieve success in learning, daily life and their future. They are less sensitive to issues and problems that occur in real life so they are unable to contribute in solving problems. Weak literacy of student and community disaster management will have a high impact on disaster risk.

Therefore, researchers conduct preliminary research to determine the level of understanding of concepts (scientific literacy) of students and know the extent to which integration of new literacy and disaster literacy is applied in schools in accordance with the demands of 21st century learning.
2. Methods
This type of preliminary research is survey research, which is the initial part in development research. Plomp [15] states that in research development there are several studies in it such as survey research, case studies, experiments and so forth. Survey research aims to gather information and data in order to find answers to a problem [16]. In this case, survey research aims to gather information and data on learning problems in schools related to the integration of new literacy and disaster literacy in responding to the challenges of the 21st century and the geographical conditions of Indonesia. The instruments in this study were (1) teacher interview guides, (2) concept tests to find out students’ understanding of concepts (scientific literacy), (3) textbook analysis sheets, and (4) teacher learning observation sheets. Data were analyzed qualitatively and quantitatively. Interview respondents consisted of 3 teachers who came from three high schools with different grades (low, medium, high). The research sample that was given the concept test consisted of 78 students of class XI also from the three high schools. The analyzed textbook consisted of 5 class XI books from different publishers that were used as references in schools.

New literacy indicators and disaster literacy used in book analysis instruments, as well as teacher learning observation sheets can be seen in Table 1. New literacy consists of data literacy, technology literacy and human literacy.

| Table 1. New Literacy and Disaster Literacy Indicators |
|------------------------------------------------------|
| **Literacy** | **Indicator** |
| Data Literacy | Using data  
Analyze data  
Communicating the results of data analysis  
Make conclusions of thinking based on data. |
| Technology Literacy | Using a computer  
Using a virtual laboratory  
Using handphone  
Using the internet. |
| Human Literacy | Communicate writing  
Collaborate in teams  
Critical thinking  
Creative and innovative thinking |
| Disaster Literacy | Linking physics learning material with appropriate disasters  
Incorporate disaster mitigation in physics learning |

The concept test instrument consists of 10 questions on the material that are valid and reliable in rotational dynamics and equilibrium of rigid bodies [17]. The concept test is a type of two-tier multiple choice test consisting of objective questions, the level of student confidence and accompanied by answers to open reasons. Concept tests are analyzed according to the categories in Table 2. The students’ conceptual understanding levels are, further, simplified into three categories [18], namely: Sound Understanding (SU), Specific Misconception (SM), and No Understanding (NU), as described in Table 3.
4

Table 2. Categories of Concept Understanding Level

| Concept Understanding Level | Code | Objective test | Confidence | Reason |
|-----------------------------|------|----------------|------------|--------|
| Sound Understanding         | SU   | True           | Very Sure/ Sure Enough | Responses that included all components of the validated response |
| Partial Understanding       | PU   | True           | Very Sure/ Sure Enough | Responses that included at least one of the components of validated response, but not all the components. |
| Partial Understanding with Specific Misconception | PUSM | True | Very Sure/ Sure Enough | Responses that showed understanding of the concept, but also made a statement, which demonstrated a misunderstanding. |
| Specific Misconception      | SM   | True or False  | Very Sure/ Sure Enough | Responses that included illogical or incorrect information. |
| No Understanding            | NU   | True or False  | Not Sure/ Less Sure    | Repeated the question; contained irrelevant information or an unclear response; left the response blank. |

Table 3. Reduction of Concept Understanding Level

| Initial Code | Final Category | Final Code |
|--------------|----------------|-----------|
| SU           | Sound Understanding | SU       |
| PU           | Specific Misconceptions | SM |
| PUSM         | Specific Misconceptions | SM |
| SM           | No Understanding    | NU       |

3. Results and Discussion

The results of interviews with 3 respondents indicate that there are almost the same problems in all three grade schools, as illustrated in Table 4. In general, teachers still carry out traditional teaching, namely teacher-centered learning. The teacher explains more about the teaching material, and students are less actively involved in learning. Very little discussion and presentation activities that practice communication and collaboration skills between students. Experimental activities are also rarely performed, so students' skills in data collection processing and data analysis are also poorly trained. Students are also rarely involved with learning activities based on information and communication technology. This means that learning in schools has not yet trained students' new literacy skills, namely data literacy, technological literacy and human literacy demanded by 21st century learning.

Table 4. Interview results with 3 high school teacher respondents

| Questions                                                                 | Answers                                                                                       |
|---------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| What models and methods are applied in learning.                           | The teacher explains more about the material (lecture method). Although they have designed a model such as Problem Based Learning (PBL), it is difficult to do. |
| What are the obstacles in applying the learning model.                    | Lesson Plane using a certain model is available, but in practice it is always short of time. A lot of time is spent explaining the material. |
Does it involve students in processing data.  
How many times in one semester  
Data processing is rarely performed, depending on 
Basic Competencies (KD), a maximum of 2 times in one semester

Are there discussion and presentation activities in class  
Rarely done because of time problems.  
When doing presentations, there is less interaction between students

Do students understand the concepts of physics well, or just memorize the formula  
Students understand the concepts less, they are more interested in memorizing formulas.

How to improve students' understanding of concepts and avoid misconceptions  
Students are given practice questions and discussed with the teacher

In addition, teacher-centered learning results in students not understanding the concepts and only interested in memorizing formulas. Teachers' efforts to improve understanding of concepts and overcome misconceptions are only by giving practice questions and the solutions are discussed in class. This shows that there are also problems in the scientific literacy of students, especially the understanding of low physics concepts and misconceptions.

The low understanding of student concepts and misconceptions are indicated from the results of the concept tests given to 78 sample students from 3 different grade schools. The concept test results show that students' understanding of concepts is still low and students experience misconceptions even though they have studied the material being tested, as can be seen in Figure 1.

![CONCEPT UNDERSTANDING CATEGORIES](image)

**Figure 1.** The level of understanding of student concepts

The level of concept understanding in high school grad (SMA A), middle grade (SMA B) and low grade (SMA C) is in accordance with their school grad, both in the category of concept understanding (SU), misconception (SM), and not understanding the concept (NU). In general, the three schools showed that students' understanding of the concept was still low (8-28%) even though they had studied the material being tested. Students experienced a fairly high misconception (20-34%) in all three schools, and more students did not understand the concept (42-72%). This happens because learning is more exposure to the material by the teacher, more student activity in the discussion of questions, and not involved in the process of concept discovery. In the end students only memorize formulas / equations without understanding the physical concepts that exist in these equations.
Figure 2(a). The percentage of questions for which the objective answer is correct

Figure 2(b). Category understanding concepts of students who answer objectively correctly.

Apart from interviews, the allegations of students who memorized the formula were also revealed from the results of the concept test analysis. Figure 2 (a) is the percentage of students who answered 10 objective item items correctly (ignoring reason answers), which is 46%. An interesting phenomenon occurs, it turns out that of the 46% of students who answer objectively correctly, not all of them give answers to reasons correctly as well. Figure 2 (b) shows that only a small proportion (7%) of students really understood the concept (SU), around 16% of students Partial Understanding (PU) the concept by just writing down formulas/equations, without any explanation on the reasoning answers. While most students (23%) do not understanding (NU) the concept because they do not know the answer to the reason even though the objective answer is correct, it is suspected that this student only guessed the answer. Students are categorized to understand the concept if they can answer the
objective and reason correctly. Meanwhile, indications of students who only memorized the formula revealed from the answers to their reasons that answered the objective correctly, but in the answer to the reason only write down the formula / equation without any adequate explanation (PU categories). Examples of students' answers to question no 1 (Figure 3), which answered objectively correctly, but included in the categories SU, PU, M and NU can be seen in Figure 4 and 5.

Poor understanding of concepts and misconceptions is a problem often occurs in middle school students or in college students [19,20,21]. The problem of scientific literacy will always arise if the teacher does not involve students in discovering student concepts through experimental activities. In learning that scientific literacy is the goal, students are not given material in a hurry, but they need time to explore, make observations, state inconsistencies and turn out to be wrong, test ideas, do something, and other activities [22].

Sebuah batang yang panjangnya L, hendak diputar agar bergerak rotasi dengan sumbu putar pada pusat batang tersebut (seperti pada gambar). Apabila besarnya gaya untuk memutar tongkat adalah $F_1 = F_2 = F_3 = F_4$ (Newton), maka manakah pernyataan di bawah ini yang benar ….

a. $F_1$ memiliki momen gaya paling besar
b. $F_4$ memiliki momen gaya paling besar
c. Momen gaya pada $F_3$ lebih besar dari momen gaya pada $F_4$
d. Momen gaya pada $F_1$ sama besarnya dengan momen gaya pada $F_4$

Apakah kamu yakin dengan kebenaran jawaban kamu?

a. sangat yakin  b. yakin  c. kurang yakin  d. tidak yakin

Beri alasan atas alasan jawabannya dan apa persamaan yang digunakan :

………………………………………………………………………………………………………………………………………………………………………………

………………………………………………………………………………………………………………………………………………………………………………

………………………………………………………………………………………………………………………………………………………………………………

………………………………………………………………………………………………………………………………………………………………………………

Figure 3. Question no 1. of the Concept Test.[17]
Furthermore, the results of the analysis of 5 physics class XI textbooks used as a reference in learning can be seen in Figure 6. The book analysis is carried out to see the extent of the integration of the new literacy and disaster literacy components in the book. New literacy consists of data literacy, technological literacy and human literacy.
The book analysis of the results shows that the integration of new literacy and disaster literacy loads is still very low (Figure 6). The integration of new literacy components in textbooks is only a maximum of 14%, while the integration of disaster literacy components in textbooks is only around 7%. This shows that the textbooks in the field do not meet the demands of 21st century learning, especially in practicing students’ new literacy skills. In addition, the textbook also does not contain a component of disaster literacy in an effort to provide students with an understanding of disasters that are relevant to material physics and how disaster mitigation efforts are in learning physics.

Furthermore, the results of observations on teacher learning also show that new literacy and disaster literacy have not been integrated in the learning process. The integration of data literacy, technology literacy, human literacy and disaster literacy in the learning process is still relatively low (Figure 7).
The low level of new student literacy is a problem that needs to be overcome so that students can compete to live in the revolutionary 4.0 era. The needs of students in the 4.0 revolution era are new literacy, namely data literacy, technological literacy and human literacy [23]. Modern civilization gave birth to demands for technological literacy, in the form of a person's ability to provide, use, manage, evaluate, and understand technology [24]. Technology literacy does not merely require students to know computers and their applications, but also increases students' ability to use appropriate technology safely, responsibly, creatively, and effectively.

As a solution to the problems outlined above, it is necessary to develop a teaching material that contains various activities to improve new literacy and disaster literacy for students. Teaching materials are also designed to improve students' understanding of physics concepts and remediate misconceptions (scientific literacy). Experimental activities on teaching materials are equipped with laboratory virtues so that students can vary the physical quantity variables in finding physical equations. One of the learning models that have a positive impact on improving understanding of concepts (scientific literacy) is a cognitive conflict-based learning (CCBL) model [25]. In general, teaching materials to be developed can train students' skills in facing the 21st century.

4. Conclusions
Implementation of learning in schools still uses traditional teaching approaches or teacher-centered learning. Students' understanding of concepts (scientific literacy) is also low and misconceptions occur in students. Learning in schools has not yet considered the 21st century learning needs and geographical conditions of Indonesia, namely the ability of new literacy and disaster literacy. This can be seen from the integration of new literacy and disaster literacy in the learning process and teaching materials (textbooks) used in schools are still low. Therefore, the recommendations of this preliminary study are that physics teaching materials need to be developed that integrate new literacy and disaster literacy, and can improve students' understanding of concepts (scientific literacy) in accordance with the demands of 21st century learning. The integration of new literacy and disaster literacy in the learning process and textbooks used is still low. Understanding of student concepts is also low and misconceptions occur. Therefore, the recommendation from this preliminary study is the need to develop physics teaching materials that integrate new literacy and disaster literacy, and can improve students' understanding of concepts according to the demands of the 21st century.

Acknowledgments
This research was funded through a superior tertiary research grant/ Penelitian Unggul Perguruan Tinggi-Dasar (PUPT-Dasar) from PNBP Universitas Negeri Padang, funding for 2019.

References
[1] Ibda, H. (2018). Penguatan Literasi Baru pada Guru Madrasah Ibtidaiyah Dalam Menjawab Tantangan Era Revolusi Industri 4.0. J of Research and Thought of Islamic Educ, Vol. 1, No. 1, 1-21. http://jurnaliaimptianak.or.id/index.php/jrtie/download/1064/534
[2] Suwardana, H. (2017). Revolusi Industri 4.0 Berbasis Revolusi Mental. Jati Unik, Vol. 1, No. 2, 102-110. http://ojs.unik-kediri.ac.id/index.php/jatiunik/article/download/117/87
[3] Wardana, M.A.K. (2018). Pengaruh Model Pembelajaran Kooperatif Berbasis Multimedia, Seminar Nasional Riset Inovatif 2018 ISBN 978-602-6428-73-8 file:///C:/Users/HP/Downloads/1549-37-1903-1-10-20190128.pdf
[4] Yahya, M. (2018). Era Industri 4.0: Tantangan dan Peluang Perkembangan Pendidikan Kejuruan Indonesia. Universitas Negeri Makasar, 1-25, http://eprints.unm.ac.id/6456/1/ERA%20INDUSTRI%204.0-%20TANTANGAN%20DAN%20PELUANG%20PERKEMBANGAN%20PENDIDIKAN%20KEJURUAN%20INDONESIA%20.pdf
[5] Brown, L.M., & Haun, J. (2014). Literacy and Disaster for Seniors. Springer, New York, 249-290.
[6] Sampurno, P.J., Sari, Y.A., & Wijaya, A.D. (2015). Integrating STEM (Science, Technology, Engineering, Mathematics) and Disaster (STEM-D) Education for Building Students’ Disaster Literacy. Int J of Learn and Teach Vol. 1, No. 1, 73-76. https://www.semanticscholar.org/paper/Integrating-STEM-(Science%20-%20Technology%20-%20Engineering%20-%20Sampurno-Sari/964ad09406be85052e5a8179b315d855b7a5c73c

[7] Chung S C, and Cherng J Y (2016) Disaster Prevention Literacyamong School Administrators and Teachers: A study on the Plan for Disaster Prevention and Campus Network Deployment and Experiment in Taiwan, J of Life Sci. 10 (2016) 203-214, https://pdfs.semanticscholar.org/36c6/9f616c8e18fa3ae3431938916679cb6a669.pdf

[8] Mukhtar, M. Z. (2017). Disaster Literacy in Communication Perspective. Universitas Muhammadiyah Yogyakarta. http://repository.umy.ac.id/handle/123456789/13380 http://repository.umy.ac.id/bitstream/handle/123456789/13380/1Bencana%20dalami%20Perspektif%20Komunikasi%20for%20UMY%20repository.pdf?sequence=1&isAllowed=y

[9] Halliday, D., Resnick, R., & Walker, J. (2011). Fundamental of Physics. 9th Edition. John Wiley & Sons, Inc, United States of America, https://www.studocu.com/en/document/air-university/fundamental-of-thermal-sciences/other/fundamentals-of-physics-9th-edition-hallidayresnickwalker/2995298/view

[10] Young, H. D. (2012). College Physics. 9th Edition, Addison-Wesley

[11] Mahpudin, A., & WahyuPuadi, E.F. (2018). Rancang bangun Augmented Reality (AR) Berbasis Android untuk Pengembangan Media Pemelajaran Fisika. Seminar Nasional Edusaintek, 550-560. https://journal.unimus.ac.id/index.php/psn12012010/article/view/4255

[12] OECD (2014), PISA 2012 Results: What Students Know and Can Do – Student Performance in Mathematics, Reading and Science (Volume I, Revised edition, February 2014), PISA, OECD Publishing. http://dx.doi.org/10.1787/9789264201118-en.

[13] Gurria A (2015) PISA 2015 Results in Focus, https://www.oecd.org/pisa/pisa-2015-results-in-focus.pdf

[14] Zulkarnaini (2018). Literasi Bencana Kunci Mitigasi. Kompas, 27 Desember 2018 18:23 WIB, https://kompas.id/baca/nusantara/2018/12/27/literasi-bencana-kunci-mitigasi

[15] Plomp T, N Nieven (2013). Educational Design Research, Part.A: An Introduction. SLO. Netherlands Institute for Curriculum Development. https://slo.nl/publish/pages/4474/educational-design-research-part-a.pdf

[16] Ali M and M Asrori (2014) Metodologi dan Aplikasi Riset Pendidikan, Jakarta: Bumi Aksara. ISBN,978-602-207-403-5.

[17] Putri L A (2017) Identifikasi Miskonsepsi Peserta Didik Kelas XI SMA N 5 Yogyakarta Pada Materi Dinamika Rotasi Dan Kesetimbangan Benda Tegar Menggunakan Soal Pilihan Ganda Beralasan Terbuka, http://digilib.uin-suka.ac.id/29719/

[18] Mufit, F., Fauzan, A., & L. (2019, June 27). The Effectiveness of Cognitive Conflict-Based Learning Model to RemEDIATE Misconception. https://doi.org/10.31227/osf.io/7ugr5

[19] F Mufit et al 2019 J. Phys.: Conf. Ser. 1317 012156

[20] Liu G and N Fang (2016) Student Misconceptions about Force and Acceleration in Physics and Engineering Mechanics Education, Int J of Eng Educ Vol. 32, No. 1(A), pp. 19–29, 2016, Printed in Great Britain, https://dialnet.unirioja.es/servlet/articulo?codigo=6902012

[21] Suastika, T Jhoni, & T Utami .2015. Penelusuran Miskonsepsi Mahasiswa Tentang Matriks Menggunakan Certainty of Response Index. Prosiding Seminar Nasional Fisika (E-Journal) SNF2015, Volume IV, Oktober 2015. Retrieved from http://snf-unj.ac.id/kumpulanprosiding/snf2015/

[22] Ronis, D. (2001). Problem-Based Learning for Math and Science: Integrating Inquiry and the Internet. United States of America: A Pearson Education Company, Skylight Training and Publishing, Inc
[23] Ibda H (2019) Indonesian Learning Based New Literacy in University to Answer the Fourth Industrial Revolution Era, Jalabahasa, Vol. 15, No. 1, Mei 2019, hlm. 48—64, http://www.jurnal.balaibahasajateng.id/index.php/jalabahasa/article/download/227/173

[24] Danim S (2019) Literasi Pendidikan Era Revolusi Industri 4.0, Posiding Seminar Nasional Pendidikan Program Pascasarjana Universitas PGRI Palembang 12 Januari 2019. https://jurnal.univpgri-palembang.ac.id/index.php/Prosidingpps/article/download/2509/2332

[25] Mufit F et al 2018. IOP Conf. Ser.: Mater. Sci. Eng. 335 012072