

DEVELOPING MOBILE-BASED PROJECT-BASED LEARNING MODULE FOR PROJECT MANAGEMENT COURSES IN VOCATIONAL EDUCATION

Sarwandi
Universitas Negeri Padang

M. Giatman
Universitas Negeri Padang

Sukardi
Universitas Negeri Padang



Dedy Irfan
Universitas Negeri Padang

Abstract

The purposes of this research were (1) to design and implement the development of mobile-based e-modules, (2) to know the students' and lecturers' responses toward the development of the mobile-based e-modules, and (3) to know the students' learning outcomes after using the mobile-based e-modules. The research employed a Research and Development with the 4D development model. The participants of this study were 54 students and three lecturers of construction engineering education. The data on the students' and lecturers' responses to the development of mobile-based e-modules were obtained using the questionnaire method. The results of the study show that the design and implementation of the developed mobile-based e-modules were successful based on several tests conducted. The successfully developed e-modules can be seen from the students' responses, in which 64% are included in the Very Practical category, and only 36% are in the Practical category. On the other hand, the results of the lecturers' responses show a Very Practical category by the percentage of 100%. As a consequence, the students' learning outcomes are declared complete at 100% and increase with a gain score of 0.44 (moderate) from 54 students in the project management course.

Keywords: *e-module, mobile-based, project based learning, project management, vocational education*

Permalink: <http://dx.doi.org/10.21831/jpv.v9i2.25947>

Contact Sarwandi  wandikocan02@gmail.com
 Department of Technology and Vocational Education, Graduate
School of Universitas Negeri Padang
Jl. Prof. Dr. Hamka, Air Tawar Bar., Kec. Padang Utara, Kota
Padang, Sumatera Barat 25173, Indonesia

INTRODUCTION

Changes in the world are now entering the era of industrial revolution 4.0 or the fourth world industrial revolution, where technology becomes a necessity in human life. Everything has become limitless with unlimited use of computational power and data, due to the massive development of the internet and digital technology as human and machine movements and connectivity. The industrial revolution has changed the way humans work from using hands to turning into using machine tools so that they will disrupt various human activities.

The birth of Industry 4.0 can increase digitalization which is driven by four factors (Yahya, 2018), namely: (1) increased data volume, computational power, and connectivity; (2) the emergence of analysis, capability and business intelligence; (3) the occurrence of new forms of interaction between humans and machines; and (4) improvement of digital transfer instructions to the physical world, such as robotics and 3D printing. Hermann, Pentek, and Otto (2016) suggest that there are four industrial design principles 4.0. First, interconnection (connection), namely the ability of machines, devices, sensors, and people to communicate with each other through the Internet of Things (IoT) or the Internet of People (IoP). This principle requires collaboration, security, and standards. Second, information transparency, which is an information system's ability to create virtual copies of the physical world by enriching digital models with sensor data, including data analysis and information provision. Third, technical assistance which includes: (a) the ability of the assistance system to support humans by combining and evaluating information consciously to make the right decisions and solve urgent problems in a short time; (b) the ability of the system to support humans by carrying out various tasks that are unpleasant, too tiring, or unsafe; (c) visual and physical assistance. Fourth, decentralized decisions, which are the ability of the virtual physical system to make their own decisions and carry out their tasks as effectively as possible.

If you want to compete in the current digital era, Indonesia needs to immediately improve the capabilities and skills of human resources through education, become operators, and reliable analysis as a driver of the industry to achieve competitiveness and high

productivity (Syamsuar & Reflianto, 2018). By doing the aforementioned actions, Indonesia can jump into a developed country in the 4.0 industrial revolution. Wolter (Sung, 2018) identified the challenges of industry 4.0, namely: (1) information technology security issues; (2) reliability and stability of production machinery; (3) adequate shelling skills; (4) reluctance to change by stakeholders; and (5) loss of a lot of work because it turns into automation. Irianto (2017) simplifies the challenge of industry 4.0, namely: (1) industry readiness; (2) trusted workforce; (3) ease of socio-cultural arrangements; (4) diversification and job creation and industry opportunities 4.0, namely: (a) ecosystem innovation; (b) competitive industrial base; (c) investment in technology; and (d) integration of small and medium enterprises (SMEs) and entrepreneurship.

Challenges and opportunities for industry 4.0 to prevent various impacts on people's lives, one of which is the problem of unemployment. Data from the Central Bureau of Statistics (*Badan Pusat Statistik* or BPS) in 2017 also show the number of unemployed people from vocational high school (*Sekolah Menengah Kejuruan* or SMK) ranks the highest, namely 9.27%, followed by high school (*Sekolah Menengah Atas* or SMA) graduates of 7.03%, Diploma III (D3) graduates of 6.35 %, and the university graduates of 4.98%. It was identified that the cause of the high contribution of vocational education to the number of unemployed people in Indonesia was, one of which, caused by the lack of special skills and soft skills possessed. The Director-General Mukti (Sumber Daya IPTEK & DIKTI, 2018) said that human resources determine the progress of a country. Moreover, Indonesia must be ready to face the industrial revolution 4.0 or fourth-generation industry. He also believes that Indonesian Universities can survive in this era of industrial revolution if implementing 4C: (1) Critical Thinking, namely being skeptical and critical. (2) Creativity, which is, being able to produce innovations. (3) Communication, in which science and technology that are made, must be accepted by the public correctly and does not cause misunderstanding. (4) Collaboration, which is to cooperate and understand each other.

Answering the challenges of industry 4.0, Bukit (2014) states that vocational education as education is different from other educa-

tion, so it must have the following characteristics: (1) oriented to individual performance in the world of work; (2) special justification on real needs in the field; (3) curriculum focus on psychomotor, affective, and cognitive aspects; (4) the benchmark for success is not limited to school; (5) sensitivity to the world of work; (6) fulfillment of adequate facilities and infrastructure; and (7) community support. The challenge of the 4.0 industrial revolution must be answered quickly and precisely, so as not to affect increasing unemployment. The government seeks to respond to these challenges by focusing on improving the quality of human resources through vocational education in 2018. The government, through cross-ministerial and institutional policies, issued various policies. One of the government's policies is the revitalization of vocational education in Indonesia. Support from the government must include (1) a learning system, (2) education unit, (3) students, and (4) educators and education personnel. The revitalization of the learning system includes (1) curriculum and character education, (2) learning materials, (3) entrepreneurship, (4) alignment, and (5) evaluation. Adjusting the curriculum and learning system that is suitable for responding to the industrial revolution 4.0 is 21st-century learning.

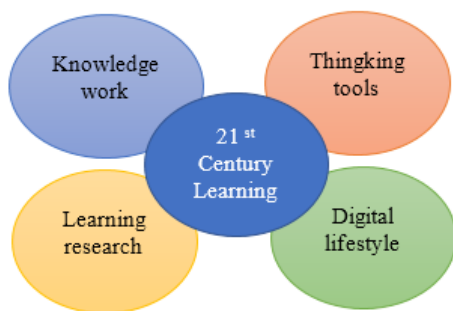


Figure 1. 21st Century Learning

According to Trilling and Fadel (2009), 21st-century learning is oriented towards digital lifestyles, critical thinking tools, learning research, and how knowledge works. The four orientations of the 21st-century learning are presented in Figure 1. Three of the orientations are very close to vocational education, namely how to work knowledge, strengthening thinking tools, and digital lifestyle. The workings of knowledge are the ability to collaborate on teams with locations, and with different tools, strengthening thinking tools is the ability to use

technology, digital tools, and services, and digital lifestyle is the ability to use and adapt to the digital era.

The content of learning in the 21st century must always adjust to changes including in the era of industrial revolution 4.0. The learning process is expected to be able to fulfill 21st-century skills, namely: (1) learning and innovation skills, including mastery of diverse knowledge and skills, learning and innovation, critical thinking and problem solving, communication and collaboration, and creativity; (2) digital literacy skills, including information literacy, media literacy and ICT literacy; (3) career and life skills, including flexibility and adaptability, and leadership and responsibility (Trilling & Fadel, 2009).

Universitas Negeri Padang has several faculties and departments, one of which is the Department of Construction Engineering Education, which, in that department, students will be taught a variety of subjects, one of which is Construction Project Management (Universitas Negeri Padang, 2017) in the aim of students can master and apply the course. In addition to compulsory courses, this Construction Project Management course is one of the requirements for conducting Industrial Field Practice. The learning process of the Construction Project Management course is carried out using modules and supporting media such as powerpoint slides. However, in reality, students still do not understand the learning of Construction Project Management so that student learning outcomes are low. Students' incomprehension of the Construction Project Management module can be seen from the learning outcomes at the final grade of this course.

Table 1. Value of 135 Students

Value	2015/2016 until 2017/2018			Average Quality Score
	Total students	Percentage (%)	Value <70 (%)	
A	4	2.64%		
A-	13	8.60%		
B+	28	18.54%		
B	27	17.88%		
B-	25	16.55%		
C+	12	7.94%	40.4%	B-
C	5	3.31%		
C-	6	3.97%		
D	1	0.66%		
E	12	7.94%		
T	-	-		

In Table 1, it can be seen that the percentage of students who achieve the highest score (A) in the Construction Project Management course is only 2.64%. Meanwhile, the students who score less than 70 are 40.4% with an average quality score of B-. The data were obtained from a population of 135 students in the academic year of 2015/2016 until 2017/2018.

Based on observations of the modules which were used in the learning process, students find it difficult to understand the material, because the material which is presented is incomplete and less attractive so that students cannot learn independently. Besides, the module does not have a module format/framework that is complete and not in accordance with the needs and conditions that exist, such as the absence of module usage instructions, explanations for students, teacher roles, final goals, competencies to be achieved, and also ability checks.

Based on the Lecture Event Unit (*Satuan Acara Perkuliahan* or SAP) and direct observation in the classroom, the learning process in the Construction Project Management course is still carried out with lecture and question and answer methods. Consequently, the learning process becomes monotonous and uninteresting; students will not experience directly in understanding the material Management of the Construction Project so that it is less meaningful. Then, a learning model is needed that requires students to be active, creative, innovative, and think critically following the character of industry 4.0.

Sani (2014) defines project-based learning as learning with long-term activities that involve students in designing, making, and displaying products to overcome real-world problems. Project-based learning (PBL) is a learning model that uses problems as the first step in gathering and integrating new knowledge based on their experience in actual activities. Through the PBL, the inquiry process begins by raising a guiding question and guiding students in a collaborative project that integrates various subjects (material) in the curriculum. PBL is an in-depth investigation of a real-world topic; it will be valuable for student attention and effort (Ministry of Education and Culture, 2014). The steps for implementing project-based learning can be explained by a diagram in Figure 2.

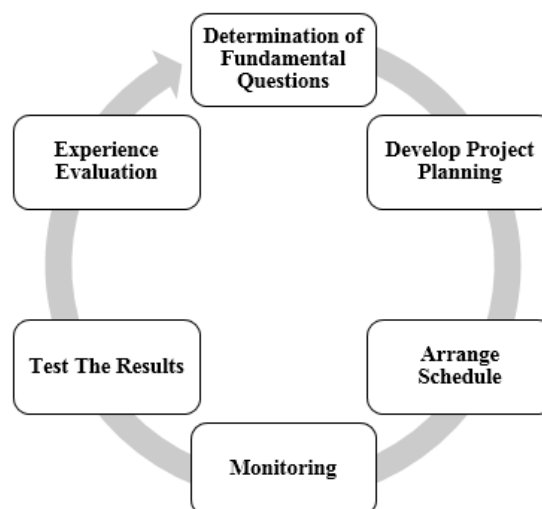


Figure 2. Project-Based Learning Steps (Source: Ministry of Education and Culture, 2014)

Based on the problems, which are, students have difficulty understanding the material so that the low final grade of the course, the modules used are not sufficient so students cannot learn independently, and the learning process still uses lecture and question and answer methods so students do not get direct experience, then, an action needs to be taken to overcome them. The action taken is developing mobile-based project-based learning e-module as a learning module in a more effective and innovative Construction Project Management course to make it easier for students to understand the material and increase independence in learning.

RESEARCH METHOD

The research method used in this study is the Research and Development research method. It also employs a 4-D modeling technique (see Figure 3) consisting of four steps (Thiagarajan & Others, 1920).

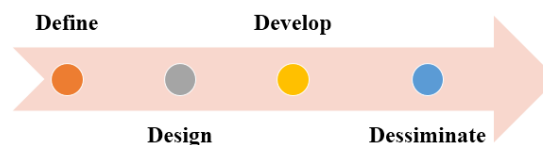


Figure 3. 4-D Modeling Steps

Research that uses the research-and-development method (Sugiyono, 2014) is a research in the form of needs analysis and is used to produce certain products as well as effectiveness tests on these products. Thus, this

development model is very suitable for developing a product so that products that are developed are valid, practical, and effective. The selection of the 4-D model in this study is based on the consideration that this type of research and model are arranged programmatically with sequences of systematic activities, aiming to produce products that are in accordance with the background of the research and are expected to support problem-solving contained within this research.

The trial subjects in this study were 54 students taking Project Management courses and three lecturers of Project Management courses. The research data were collected using the following techniques: observation, questionnaire, and test. Observations were done to observe the project management learning process related to the modules used so far. In addition, the questionnaire used in this study was a Likert scale questionnaire. The questionnaire was used to validate material and media experts, and also to assess the responses of students and lecturers to the use of e-modules developed. Then, the tests used during summative tests are pre-test and post-test to determine the effectiveness of e-modules as teaching materials that can help students understand project management material.

RESULTS AND DISCUSSION

The development of this mobile-based project-based learning module was developed using a 4-D model consisting of four stages, namely, Define, Design, Develop, and Disseminate. Each stage is elaborated as follows.

Define

The initial stage in developing the e-module was carrying out research and gathering information by several processes, such as observation, curriculum analysis, analysis of student characteristics, and analysis of the concepts. Each process is described as follows.

Observation

Observations were carried out in the Department of Civil Engineering Education of the Construction Engineering Education Study Program at the Universitas Negeri Padang, especially in the Project Management course, aimed to find out what problems were faced in

the field related to the Project Management course. One of the problems that occurred was that students had difficulty in understanding Project Management material, the modules used were inadequate, and the learning process still used lecture methods and responsibilities, so students did not get a direct understanding of Project Management concepts.

Curriculum Analysis

This curriculum analysis refers to the Semester Learning Plan (*Rencana Pembelajaran Semester* or RPS) of Project Management courses. It is to find out the subject/subject being taught is in accordance with the standards of competence and basic competencies of the course. The discussion material developed in this e-module, as presented in Table 2, includes the calculation of the cost budget plan (*Rencana Anggaran Biaya* or RAB) and project work schedule preparation.

Table 2. Material Discussion

Module I	Module II
1. Calculation of volume in the budget plan	1. Types of work schedules
2. Calculation of unit prices in the budget plan	2. Establishment of network planning (NWP)
3. Complete calculation of the budget plan	3. Making an S diagram plan

Student Characteristics Analysis

The age of students studying this course generally 20 years old and above. Airasian et al. (2001) basically state that, at that age, every student is in the "create" category, which has been declared capable of designing, building, planning, producing, finding, renewing, perfecting, strengthening, beautifying, and also changing. Therefore, at that age, students have been given the opportunity to develop their own knowledge and understanding.

At the achievement of this stage, students are given the opportunity to increase their knowledge and understanding independently, and in the use of learning technology, it is hoped that they will be more motivated in learning. Studying the characteristics of students is also essential to make it easier to arrange the level of language in the e-module.

Concept Analysis

Concept analysis aims to determine the content and subject matter which are needed in the Project Management course. The development of this e-module is based on the main concepts that will be developed systematically and identifies supporting concepts that are relevant and related to the material in the Project Management course. The main concept in this Project Management course is that students are able to analyze volume calculations, calculate unit prices, calculate budget plans, and are able to apply the types of work schedules, making network planning, to making S curves.

Design

At this stage, the researchers design the learning e-module through several stages. Each stage is elaborated as follows.

Test Preparation

At this stage, the preparation of tests is used as a tool to determine the ability of students (pre-test) and as an evaluation tool after the implementation of lecture activities (post-test) using e-modules in the Project Manage-

ment course. The tests are arranged in the form of a multiple-choice objective test. The tests that have been prepared are validated by experts in their fields with valid results or very as expected.

Media Selection

The purpose of media selection is to identify the right learning media in order to present the material presented. In this study, the selected media is a mobile-based application which is designed using an android studio. This application is the choice of researchers because it can be used in the field of learning, efficient, and lightweight for use in various types of mobile devices.

Designing Prototype

At this stage, the design framework for the display of mobile-based PBL e-module design includes the opening page, main menu, material page, presentation of material, and evaluation of multiple-choice questions. Figure 4, Figure 5, Figure 6, and Figure 7 are the display of each page in the mobile-based project-based learning e-module for Project Management courses.



Figure 4. The Opening Page

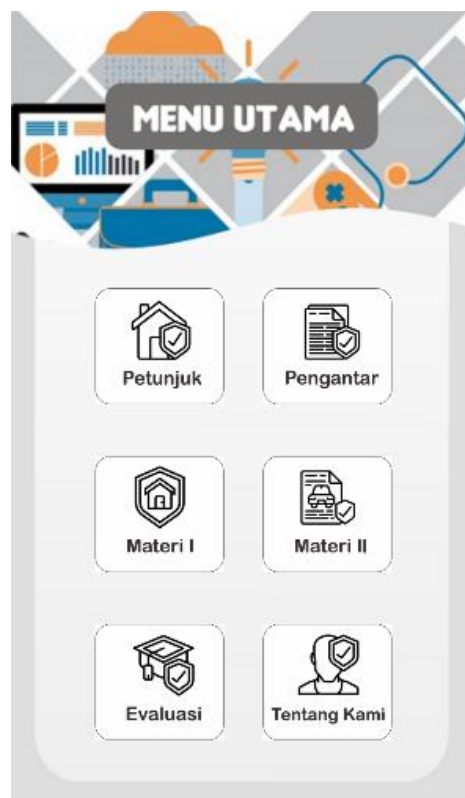


Figure 5. Home Page

Figure 4 shows the opening page to enter the main menu. Figure 5 presents the display of the home page, which is the main page that contains instructions for using e-modules, preface, material I, material II, evaluation, and profile of the developer. Figure 6 presents the material description, in which a choice of material to be studied is embedded, starting from the calculation of volume, unit price analysis, to the making of curves S. Figure 7 shows the display of material that is presented in full, making it easier for students to understand the concept of project management.

Develop

After passing the design stage, the researchers enter the development stage. This stage aims to obtain a learning e-module that is valid, practical, and effective to use. The development phase consists of evaluating material and media validation, up to practicality assessments, and the effectiveness test phase. Data retrieval validity and practicality is done by using a questionnaire. The questionnaire used previously has gone through the stage of validity testing by experts who understand the questionnaire instrument. Questionnaires that have

been tested by validators have been declared appropriate for testing material validity, testing media validity, and practicality tests.

Validity Analysis

The validation test phase is done to obtain a valid learning e-module status. Validation test data are obtained through validation instruments filled in by the validator. The validator also has the right to provide input on the material and media of the e-learning module developed; then, the input can be used as a revision for researchers in the development of this learning e-module. The results of the assessment given from each validator were analyzed using the statistical Aiken's V formula. Table 3 and Table 4 present the result of the questionnaire data analysis from the results of expert validation testing.

Table 3. Results of Media Validation Analysis

Validator	Validity Result	Category
Validator I	0.85	Valid
Validator II	0.83	Valid
Validator III	0.94	Valid
Average	0.87	Valid



Figure 6. Material Description



Figure 7. Material Presentation

Table 4. Results of Material Validation Analysis

Validator	Validity Result	Category
Validator I	0.76	Valid
Validator II	0.80	Valid
Validator III	0.93	Valid
Average	0.83	Valid

Based on data analysis in Table 3 and Table 4, it can be seen that the values of media and material validation are not in the range of values <0.66 with invalid categories. Thus, so it indicates that the project of the e-module of mobile-based project-based learning in Management courses is valid.

Practicality Analysis

Practical testing is a field test that is useful to see the practicality of this mobile-based e-module. E-modules are said to have high practicality if they are practical and easy to use. Practical test data were obtained from filling in the practicality questionnaire of the e-learning module, which was filled by three lecturers who taught Project Management courses and 54 students who took Project Management courses. These data are obtained after learning using e-modules that have been developed. The results obtained from the practicality test of lecturers and students can be seen in Table 5 and Table 6.

Table 5. Results of Practical Analysis of Lecturers

Respondent	Result	Category
Respondent I	97	Very Practical
Respondent II	95	Very Practical
Respondent III	84	Very Practical
Average	92	Very Practical

Table 6. Results of Practical Analysis of Students

Respondent	Result	Category
45 Students	64%	Very Practical
	36%	Practical

Effectiveness Analysis

Summative tests were carried out in the form of field tests with pre-test and post-test designs. The instrument of data collection used to determine the effectiveness of this product is a multiple-choice written test with questions

about procedural knowledge to uncover the level of understanding of students. The e-module that has been developed is then implemented to students to find out the differences caused by the use of the e-module. Summative tests are conducted on 54 VI-semester students who take Project Management courses. It is obtained that the average pre-test result of students' learning outcomes before using e-modules is 57 with the value of quality C, while the average post-test of their learning outcomes after using e-modules is 76 with a quality value of B+ or categorized as Very Good. Furthermore, the e-module is said to be effective if the gain score obtained is ≥ 0.30 or at least in the moderate category. The gain score obtained can be seen in Table 7.

Table 7. Gain Score Analysis

N	Pre-test Average	Post-test Average	Gain Score
54	57	76	0.44
	Category		Moderate

Student learning outcomes are said to be complete if they get a minimum score of ≤ 50 or a minimum in the C- category. If seen from the completeness of student learning outcomes after using the learning e-module, students get a minimum score of 65 or in the B- category, so that it indicates that all students complete 100% with the data are presented in Table 8.

Table 8. Analysis of Learning Outcomes

N	Max Value	Min Value	Range of Values	
			<50	≥ 50
54	94	65	0	54

Disseminate

The dissemination phase is carried out by applying this e-module in the teaching and learning process in the Project Management course. During the dissemination process, students seriously listen to the explanation of the e-learning module. Distribution is also carried out by promoting e-modules at other universities with the same majors as Construction Engineering Education. Moreover, dissemination is carried out by spreading the e-modules through Playstore and social media with the aim to be able to promote a wider scope, so that e-modules can be known and used by more users.

CONCLUSION

This research has produced a mobile-based project-based learning e-module that contains text and images on Project Management subject matter. The e-module consists of several sections, such as the main menu, material page, evaluation page, and others.

Experts state the e-learning module for Project Management courses as valid e-modules with an average rating of media aspects of 0.87, as well as material aspects of 0.83. For the e-module's practicality level, as assessed by subject lecturers, it obtains an average percentage of 100% in the category of Very Practical, and as assessed by students, it obtains an average percentage of 64% which is in the category of Very Practical while 36% is in the Practical category. The e-learning modules produced are also stated to be effective in improving student learning outcomes, which are known from classical judgments that there are differences in students' learning outcomes before and after the use of media in the learning process. In addition, it is also supported by the Gain score calculation, which is worth 0.44 with the moderate category.

Based on conclusions and the results of research that has been feasible and tested, the implication is that this study has produced a project-based learning e-module that can be used in lectures for Project Management courses. The mobile-based e-module is chosen because it is faster and supports more active learning so that students have a high enough ability to be able to provoke direct and independent understanding, interests, and learning experiences. This e-module can be used easily by lecturers and students. The importance of this mobile-based project-based learning e-module for Project Management courses is that the e-module developed can foster creativity, educator innovation in creating a pleasant learning environment, fostering interest and desire of students to study with lecturers' direction and independently.

ACKNOWLEDGMENTS

This research was funded by the Ministry of Research, Technology, and Higher Education. The researchers are very grateful to all the lecturers and students who helped to complete this research.

REFERENCES

- Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., Raths, J., & Wittrock, M. C. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of educational objectives*. (L. W. Anderson & D. R. Krathwohl, Eds.). New York, NY: Longman.
- Bukit, M. (2014). *Strategi dan inovasi pendidikan kejuruan: Dari kompetensi ke kompetensi*. Bandung: Alfabeta.
- Hermann, M., Pentek, T., & Otto, B. (2016). Design principles for industrie 4.0 scenarios. In *Proceedings of the Annual Hawaii International Conference on System Sciences* (Vol. 2016-March, pp. 3928–3937). IEEE Computer Society. <https://doi.org/10.1109/HICSS.2016.488>
- Irianto, D. (2017). Industry 4.0: The challenges of tomorrow. In *Kongres VIII Badan Penyelenggara Pendidikan Tinggi Teknik Industri Indonesia (BKSTI) - Seminar Nasional Teknik Industri (SNTI) dan Seminar Nasional Terpadu Keilmuan Teknik Industri (SATELIT) 2017*. Malang: Department of Industrial Engineering, Faculty of Engineering, Universitas Brawijaya.
- Ministry of Education and Culture. (2014). *Materi pelatihan guru: Implementasi kurikulum 2013 tahun ajaran 2014/2015 - mata pelajaran IPA SMP/MTs*. Jakarta: Ministry of Education and Culture of Republic of Indonesia.
- Sani, R. A. (2014). *Pembelajaran saintifik*. Jakarta: Bumi Aksara.
- Sugiyono, S. (2014). *Metode penelitian pendidikan pendekatan kuantitatif, kualitatif, dan R&D*. Bandung: Alfabeta.
- Sumber Daya IPTEK & DIKTI. (2018). Formula 4C untuk bertahan pada era revolusi industri 4.0. *Sumber Daya Iptek Dan Dikti Kemenristekdikti*. Retrieved from <http://sumberdaya.ristekdikti.go.id/index.php/2018/05/04/formula-4c-untuk-bertahan-pada-era-revolusi-industri-4-0/>

- Sung, T. K. (2018). Industry 4.0: A Korea perspective. *Technological Forecasting and Social Change*, 132(C), 40–45. <https://doi.org/10.1016/j.techfore.2017.11.005>
- Syamsuar, S., & Reflianto, R. (2018). Pendidikan dan tantangan pembelajaran berbasis teknologi informasi di era revolusi industri 4.0. *E-Tech: Jurnal Ilmiah Teknologi Pendidikan*, 6(2). <https://doi.org/10.24036/et.v2i2.101343>
- Thiagarajan, S., & Others. (1920). *Instructional development for training teachers of exceptional children: A sourcebook*. Washington, DC: National Center for Improvement of Educational Systems (DHEW/OE).
- Trilling, B., & Fadel, C. (2009). *21st Century skills: Learning for life in our times*. San Francisco, CA: John Wiley & Sons.
- Universitas Negeri Padang. (2017). Sistem informasi kurikulum Universitas Negeri Padang. Retrieved from <http://kurikulum.unp.ac.id/>
- Yahya, M. (2018). Era industri 4.0: Tantangan dan peluang perkembangan pendidikan kejuruan Indonesia. In *Inaugural Professorial Speech on Vocational Education*. Makassar: Faculty of Engineering, Universitas Negeri Makassar.