J. Pijar MIPA, Vol. 18 No. 1, January 2023: 6-12 ISSN 1907-1744 (Cetak)
DOI: 10.29303/jpm.v18i1.4267 ISSN 2460-1500 (Online)

DIGITALIZATION OF THE LABORATORY MANAGEMENT MODULE FOR STRENGTHENING THE LABORATORY SKILLS OF PROSPECTIVE SCIENCE TEACHERS

Susanti[1], Ani Widyawati[1], Laily Rochmawati Listiyani[1], Tri Astuti Arigiyati[2], and Tias Ernawati[1*]
[1]Science Education Department, Universitas Sarjanawiyata Tamansiswa, Yogyakarta, Indonesia
[2]Mathematics Education Department, Universitas Sarjanawiyata Tamansiswa, Yogyakarta, Indonesia
*Email: tias.ernawati@ustjogja.ac.id

Received: October 25, 2022. Accepted: January 11, 2023. Published: January 30, 2023

Abstract: The transition to online learning since the start of the Covid-19 pandemic has forced all parties to respond quickly to the use of information technology. Various applications are used in the learning process. Of course, this was followed by the digitization of learning tools, including the Laboratory Management course held by the Science Education Study Program of the University of Sarjanawiyata Tamansiswa. Learning tools are needed to accommodate Course Learning Outcomes (CLO), one of which is a module. The modules are comprehensive, systematic, and accompanied by a planned learning experience designed to help students master the learning objectives. This research is a preliminary stage of research on the digitalization of module products which was carried out using the Borg and Gall models. This study aims to describe the need to develop the digitalization of the Science Laboratory Management course module to strengthen the laboratory skills of prospective science educators. The method used is a literature study of the needs and other considerations related to the development of module products. The study results stated that digitizing the Laboratory Management module makes it easier for students to access materials anywhere and anytime. Learning becomes more focused and structured. The e-module was developed by considering the laboratory skill needs of prospective science educators. The selected laboratory skill indicators include mastery of practical tools, accuracy and accuracy of work, Occupational Safety and Health, and handling of chemicals.

Keywords: *Module Digitization, Laboratory Management, Science Laboratory Skills*

INTRODUCTION

The Covid-19 pandemic that has been going on since 2019 has brought many changes in every aspect of life, including education. Face-to-face learning in higher education is temporarily suspended and replaced with online learning. Based on the Joint Decree of the Minister of Education and Culture, Minister of Religion, Minister of Health, and Minister of Home Affairs Number 05/KB/2021, Number 1347 of 2021, Number HK.01.08/MENKES/6678/2021, Number 443-5847 of 2021 concerning Implementation Guidelines. Learning in the Time of the Covid-19 Pandemic Ministerial Decree 4, which regulates face-to-face learning, still provides guidelines based on the conditions of the Covid-19 pandemic in their respective regions. At the beginning of 2022, online learning was still instructed to be carried out in all universities, even though it had begun to allow implementation with blended learning. Blended learning is one of the innovative models that integrate technology with the demands of 21st-century learning and is relevant to education during the COVID-19 period [1]. The policy of the University of Sarjanawiyata Tamansiswa in the Even Semester of the Academic Year 2021/2022 still applies whole online learning. The Science Education Study Program students thoroughly study from home and conduct face-to-face learning virtually using the university's Learning Management Systems (LMS).

Students and lecturers are required to be able to adapt quickly to the technology that is currently developing. Technology is the primary solution to obstacles in the learning process during the pandemic. The university provides LMS through the https://sipedar.ustjogja.ac.id page as an online learning facility for students and lecturers. A lecturer has to offer learning tools for his students. Online learning is increasingly evident, and it demands innovation in the tools developed by lecturers. Learning tools have begun to be arranged online digitally to be appropriate for use in virtual classrooms for teaching. In addition, many obstacles during learning require that learning devices be enabled to be accessed anywhere and anytime students want to learn. Students strived to become independent learners. Meanwhile, lecturers continue to carry out their primary duties as professional educators by transforming, developing, and disseminating knowledge [2].

During the Covid-19 pandemic, the Science Education Study Program regularly reviewed the curriculum and produced the OBE-Based Merdeka Belajar Kampus Merdeka Higher Education Curriculum product in 2021. The Science Laboratory Management course is one of the results of the curriculum review product. This course is held in even semesters. This course aims to provide skills in the management of science laboratories which include: laboratory administration, laboratory facilities and infrastructure, laboratory management

organizations, laboratory work health and safety, laboratory design, and science practicum guidelines. This course prepares prospective science educators who can master science management laboratories in junior high schools. The teacher's laboratory skills are expected to counter school challenges after Covid-19. Some of the problems of teachers in schools are due to the lack of teacher resources, difficulties in uniting teachers in the implementation of learning, low IT teacher skills, more time used to prepare for learning, teachers not having devices, and internet network constraints [3].

Following the University's Policy, the Science Laboratory Management course will continue to be conducted online. Lectures are carried out using Sipedar as LMS, assisted by the university academic portal, google suites, Youtube, and WhatsApp. In the current semester, there are various obstacles in carrying out lectures. These obstacles include (1) student learning achievement is still not optimal, (2) it is challenging to administer laboratory inventories, (3) students cannot fully predict work accidents in the laboratory, so the design of preventive measures is not optimal, (4) difficulties in designing laboratories. Science (5) students experience problems designing a junior high school science practicum. Learning during the pandemic causes students to have limited access to science laboratories. The laboratory is served virtually. It, of course, has yet to fully provide an opportunity for improving student laboratory skills. Besides, students tend to wait for learning material from the lecturer even though the course syllabus has been given. Students have yet to become independent learners. Student interest in learning decreased.

One of the efforts to overcome these obstacles is to provide structured, systematic, and exciting learning tools [4][5]. The module is a learning device arranged systematically and has a specific purpose in the learning process [6]. Modules have characteristics in the form of the most minor and complete learning units that distinguish them from other teaching materials. Technically, there are 4 module elements: the title, instructions for using the module, material, and evaluation. Modules can help reduce misconceptions during the material transfer process, especially when students start their independent study [7]. Lecturers can use the module to document complete, structured, and systematic learning resources.

The limitations of space and time in the learning process due to the pandemic demand innovation. Material concepts must be innovatively delivered quickly, accurately, effectively, practically, and easily accessible [8]. A lecturer must be able to develop teaching materials (modules) for the courses he teaches [9]. The module's presentation can be transformed into electronic form to be given the term electronic module or virtual module. Electronic modules are very effective in increasing students' learning motivation. Besides that, it is also effective in improving student learning outcomes and critical thinking skills [10]. Modules packaged in digital form provide freedom and convenience to access material wherever and whenever students want to learn. Students will be facilitated in a directed manner when doing an independent study using e-modules. It will encourage and support students' achievement of Subject Learning Outcomes.

Through this preliminary research activity, data will be obtained in the form of a needs analysis for the development of the Laboratory Management e-Module. The research questions are (1) what is the role of digital-based modules in the learning process? (2) how is the module suitable for the Science Laboratory Management course in the Science Education Study Program of the University of Sarjanawiyata Tamansiswa? (3) how does the digital module improve the laboratory skills of prospective science educators?

RESEARCH METHOD

The research is carried out in the Science Education Study Program of the University of Sarjanawiyata Tamansiswa in the Even Semester of the 2021/2022 Academic Year. This research is the preliminary stage of the whole research series on developing the Science Laboratory Management e-Module using the development model from Borg and Gall [11]. The initial study contains the steps of research and information collection. This primary research method uses a qualitative descriptive from a literature review appropriate to the needs and other considerations related to the e-Modul product. Researchers examined data from various sources of books, literature, research reports, scientific essays, theses, dissertations, and printed and electronic articles based on the selected topics [12], [13]. The initial stage in this research is done by reading data sources or literature from various trusted sources such as e-books, scientific articles, or websites, then analyzing the contents of data sources related to laboratory management. The last stage is to conclude the results of the analysis. This method is carried out to provide relevant information based on data sources and provide a clear picture of laboratories and laboratory management in schools. The study results are in the form of a qualitative description of the analysis of research needs.

RESULTS AND DISCUSSION

The Role of Digital-Based Modules in the Learning Process

Teaching materials are any variety of learning resources that can increase our

understanding of something as a form of problem-solving or as advanced material for self-improvement [14]. Teaching materials are all forms of learning materials or materials that are arranged systematically based on learning principles to achieve competencies that have been formulated to create an atmosphere that allows for learning [15]. Teaching materials are all materials used to assist teachers/instructors in learning activities in the classroom, systematically arranged and manifested in the written or verbal form [16]. Thus, teaching materials are a series of materials arranged with a specific purpose to provide convenience for students and teachers in the learning process.

Quality teaching materials are (1) suitable teaching materials, namely following content validity, where content validity states the components of the material based on knowledge; following construct validity, where all material components are interconnected; and following criterion validity, which is adjusted to textbook assessment standards from the National Education Standardization Agency, (2) teaching materials used effective, which can provide good learning outcomes, (3) practical teaching materials, which are easy to use by teachers and students [17]. Quality teaching materials are teaching materials that can accommodate the needs of students to learn, understand, and master a material concept. Aspects of validity, effectiveness, and practicality in developing teaching material must be considered.

Teaching materials have various types, with the characteristics and objectives of each. A module is a form of teaching material that is packaged entirely and systematically, which contains a set of planned learning experiences and is designed to assist students in mastering learning objectives [4], [18]. The module has characteristics in the form of the smallest and complete learning unit that distinguishes it from other teaching materials. Generally, the material in the modules presented is more complex when compared to other forms of teaching materials. Modules can be viewed as the embodiment of individual learning [19]. The module functions as a means of independent learning so that students can learn at their own pace [16], [20]. The module contains a series of learning activities that are systematically designed, contain learning objectives, and allow for self-study.

The components of the preparation of the module consist of: (1) Title; (2) Learning Instructions for Both Teachers and Students; (3) Competencies to be achieved; (4) Supporting information; (5) Practice Questions; (6) Work Instructions; (7) Evaluation and Assessment; (8) Bibliography [18], [21], [19]. The characteristics of the module teaching materials are as follows [14], [22], [7].

a. Self-Instructional; module as a means to learn yourself
b. Self-Explanatory Power; the module can explain itself by presenting simple language, readable content, and systematically arranged.
c. Self-Contained; the module contains the entire learning material to provide an opportunity to study thoroughly.
d. Self-Paced learning; the module can be used to learn at a pace that suits itself without waiting for other slower or faster learners.
e. Stand-Alone; the module can stand alone, does not depend on other teaching materials, and does not have to use other complementary teaching materials to learn.
f. Adaptive; the module adapts to the development of science and technology, is flexible to use, and can be used for a certain period.
g. User-Friendly; the module can be easily used. Every instruction and information must be helpful in the learning process. This can be achieved by selecting language and terms that are easy to understand or commonly used.
h. Individualized Learning Materials; modules are designed according to the abilities and characteristics of the students who are studying them.
i. Communicative and Interactive Learning Materials; modules are designed with practical communicative principles and involve interaction with students studying them.

In general, the module is in the form of printed teaching materials. Along with the times, the module's presentation can be transformed into digital form so that it is given the term electronic module (e-Modul) or virtual module. E-Module is a form of presenting self-study materials arranged systematically into the minor learning units to achieve particular learning objectives. It is presented in an electronic format that includes animation, audio, and navigation, which makes users more interactive with the program [8]. E-Modules are forms of teaching materials following the characteristics of teaching materials that have been packaged in a unified whole, which are systematically arranged to be studied independently and more actively by learners according to their speed or ability without guidance from the teacher [20].

The Covid-19 pandemic has also positively impacted the education sector, including the emergence of various digital-based modules. These digital modules are one of the efforts of teachers and lecturers in dealing with face-to-face limitations due to the ongoing pandemic. E-Modules can act as flexible and mobile materials. The efficiency of this form can be used anywhere and anytime when students want to learn. One of the weaknesses of web-based digital modules is

that data quota is still needed to access or download. However, the benefits of the module still outweigh the drawbacks. Digital modules make it easier for teachers and lecturers to transfer knowledge systematically and in structure. Students can learn with a clear flow even though they are not accompanied by a lecturer directly. Digital modules are also paperless, so they are environmentally friendly, facilitate documentation, and reduce operational costs. In the future, it is hoped that all modules can be converted into digital form, even though the pandemic is about to end.

The Suitability of Module Development in the Science Laboratory Management Course in The Science Education Study Program

The Science Laboratory Management course with the IPA21422 course code is one of the compulsory courses that weigh two credits. This course is held in even semesters and is offered in semester 4. This course aims to provide skills in science laboratory management which include: laboratory administration, laboratory facilities and infrastructure, laboratory management organization, laboratory work health and safety, laboratory design, and IPA practical guide. The Science Laboratory Management course has CLO, namely (1) Mastering science laboratory administration, science laboratory facilities and infrastructure, laboratory organization, occupational health and safety laboratories, (2) Designing science laboratories, and (3) Designing science practicums.

Science learning in schools should be done by involving students in the investigation. To support this learning, the school must have an adequate laboratory. For more than a century, laboratory experiences have been purported to promote central science education goals, including the enhancement of students' understanding of concepts in science and its applications; practical scientific skills and problem-solving abilities; scientific ‘habits of mind’; understanding of how science and scientists work; interest and motivation [23]. As prospective junior high school science educators, students must master concepts and theories about science and education and recognize, understand, master, and manage science laboratories in schools. A survey conducted by Sani [24] stated that the management of school laboratories needed to have been carried out correctly. The management needs to learn how to manage the laboratory. The management in question is the principal, laboratory assistants, teachers, and all related parties responsible for the school laboratory. Many school laboratories have not maximized their use and have even been transformed into classrooms or rooms far from the regular use of laboratories [25]–[29].

The teacher's lack of understanding of the meaning and function of the laboratory for science learning is the main focus of the Science Laboratory Management course in the Science Education Study Program. It is challenging for lecturers to teach students when face-to-face learning is limited due to the Covid-19 pandemic. Therefore we need a learning device in the form of teaching materials relevant to learning outcomes and the situation and conditions faced. Digital-based learning modules were chosen to be developed to overcome various obstacles being faced. The development of digital modules was chosen because this form of teaching material was considered appropriate and suitable for independent student learning due to the lack of maximum during virtual learning.

The development of digital-based modules is also appropriate in following technological developments and is suitable for generation Z. In the module; material content will be presented that can accommodate students to (1) be able to identify science laboratories and the infrastructure used, (2) be able to formulate science laboratory organizations, (3) Able to study various science laboratory designs, (4) Able to design science laboratory, (6) Able to perform laboratory administration, (7) Able to study occupational health and safety in a laboratory (8) Can categorize existing practicum tools and materials in the laboratory and how to treat it, (9) Able to design science practicum guidelines. This module allows students to become independent learners with more structured and systematic learning resources.

Improving the Laboratory Skills of Prospective Science Educators through the Implementation of E-Modules

An educational laboratory, from now on referred to as a laboratory, is an academic support unit at an educational institution, in the form of a closed or open room, permanent or mobile, systematically managed for testing, calibration, and production activities on a limited scale, using equipment and materials based on scientific methods, notably in implementing education, research, and community service [30]. Laboratories need to be in schools to support learning, especially science subjects. Science studies and tries to understand natural phenomena through observations. Science is a family of sciences with unique characteristics, namely studying real natural phenomena, either in the form of reality or events and causal relationships [31]. In essence, science includes four main elements, namely process, attitude, product, and application. These four elements are characteristics of science that cannot be separated from each other. The integrated science concept has implications for science teachers to master science from physics, chemistry,

and biology so that transferring knowledge in the classroom is carried out effectively and efficiently; it positively impacts student learning outcomes [32].

Facilities and infrastructure that can support effective learning for students include laboratories. The laboratory is a place to conduct experiments and training that encourages a safety and security culture, so the environment becomes a safe place to teach, learn, and work [33]. A laboratory is a place for observing, experimenting, practicing, and testing the concept of knowledge and technology [34]. The laboratory becomes a center of experience in observing and testing the material in the science field (covering Physics, Biology, and Chemistry) obtained in class [31]. The use of laboratories can improve the quality of science learning. So far, teachers still need to start using the laboratory; one of the reasons is that the teacher's ability to use tools and materials still needs to be improved [5]. The effectiveness of science learning will not be fulfilled if there is no support from the ability of prospective teachers to carry out activities, especially in managing laboratories as a form of success in science learning [35].

The limited ability of teachers in the aspects of mastery of science practicum, mastery of equipment, and practicum materials requires prospective science educators to improve further and master their laboratory skills. On the other hand, enthusiastic and knowledgeable teachers are necessary for the benefits of quality facilities and an established system to be fully realized [36]. Laboratory management skills are also crucial for prospective science educators to master. Laboratory management is a process of using resources efficiently and effectively [37]. Laboratory management is related to using facilities, managers, and all activities in the laboratory [34]. Laboratory management or management (Laboratory Management) is an effort to manage laboratories based on standard management concepts. The science laboratory's function to improve student learning quality depends on the teacher's view of science and learning [38]. Therefore, prospective science educators must be equipped with laboratory managerial skills.

The Science Laboratory Management E-module was developed by considering the mastery of science laboratory skills. The indicators for laboratory management skills include: (1) Knowing, being ready, and operating the tools correctly according to the practicum guide, (2) Understanding the function of practicum tools correctly, (3) Being able to choose the right tools and practicum materials, (4) Being able to use and read measuring instruments correctly, (5) Can carry out practical safety handling in the event of an accident in the laboratory, (6) Know and classify chemicals [39]. Implementing laboratory management in schools includes planning, procurement, inventory, storage, arrangement, use, maintenance, and removal [40].

The Laboratory Management course module was initially uploaded to the LMS facilitated by the university, namely through the https://sipedar.ustjogja.ac.id page. Uploading digital modules on this page will be efficient because students are used to accessing Sipedar as long as the university sets the online learning policy. Science Education Study Program students are familiar with the icons displayed on the LMS so that in the future, they will have no difficulty following the instructions presented in the electronic module. In the e-module, topics to hone and improve students' laboratory skills include (1) Laboratory and its Equipment, (2) Laboratory Design, (3) Laboratory Organization, (4) Laboratory Administration, (5) Introduction to Materials and Tools Practicum, (6) Procurement of Laboratory Equipment and Materials, and (7) Health and Safety of Laboratory Work. In addition, the e-module will also provide laboratory virtualization and various activities to achieve CLO and improve the laboratory skills of prospective science educators.

CONCLUSION

Implementing online-based Science Laboratory Management courses in the Science Education Study Program as the follow-up of the learning process policies during the Covid-19 pandemic requires directed and measured preparation. Online learning causes students to have limited access to science laboratories. Structured and effective digital-based teaching materials for the learning process can overcome these problems. Digital teaching materials make it easy for students to become independent learners. Digitizing teaching materials can provide opportunities for students to access the limitations of contextual learning in the laboratory. The Science Laboratory Management E-module is a digital teaching material that is systematically arranged and contains content for CLO achievements aimed at improving students' laboratory skills. The activities in the e-Modul are directed at the laboratory skill indicators of prospective science educators.

ACKNOWLEDGEMENTS

The author and the research team would like to thank the Institute for Research and Community Service of the University of Sarjanawiyata Tamansiswa Yogyakarta for the funding for the 2022 fiscal year based on the Agreement on the Implementation of Internal Research Number: 56/UST/LP2M/K/PDU-UST/VI/2022. Thanks are also extended to the Science Education Study Program of the University of Sarjanawiyata

Tamansiswa for the grant of research permission and to all parties who have helped carry out the research.

REFERENCES

[1] Sari, I. K. (2021). Blended Learning sebagai Alternatif Model Pembelajaran Inovatif di Masa Post-Pandemi di Sekolah Dasar. *Jurnal Basicedu*, *5*(4), 2156–2163.

[2] Kementerian Pendidikan dan Kebudayaan RI. (2020). *Permendikbud 3 Tahun 2020 Tentang Standar Nasional Pendidikan Tinggi*. 1–57.

[3] Sulung, M. H., & Erman, E. (2022). Science Teachers Innovation in Overcoming Learning Challenges During Pandemic Covid-19: A Reflection. *Jurnal Pijar Mipa*, *17*(5), 560–568.

[4] Haryanto. (2018). *Pengembangan Bahan Ajar Cetak Applied Approach*. Pusat Pengembangan Kurikulum dan Sumber Belajar LPPMP UNY.

[5] Zahara, N., & Agustina, E. (2019). Pemanfaatan Dan Pengelolaan Laboratorium Bagi Guru IPA Di Madrasah Tsanawiyah Negeri Dan Swasta Aceh Besar. *Prosiding Seminar Nasional Biotik*, *6*(1).

[6] Magdalena, I., Sundari, T., Nurkamilah, S., Ayu Amalia, D., & Muhammadiyah Tangerang, U. (2020). Analisis Bahan Ajar. *NUSANTARA*, *2*(2), 311–326.

[7] Ernawati, T., & Susanti, S. (2021). E-Modul IPA 2 Untuk Pembelajaran Mandiri Di Masa Pandemi Covid-19. *KoPeN: Konferensi Pendidikan Nasional*, *3*(1), 107–114.

[8] Sugianto, D., Abdullah, A. G., Elvyanti, S., & Muladi, Y. (2013). Modul Virtual: Multimedia Flipbook Dasar Teknik Digital. *INVOTEC*, *9*(2), 101–116.

[9] Amdayani, S., Nasution, H. A., Syuhada, F. A., & Dalimunthe, M. (2021). Validitas Dan Praktikalitas Modul Kimia Berbasis POE (Predict, Observe, Explain) Materi Koloid Pada Mata Kuliah Kimia Umum. *Jurnal Pendidikan Pembelajaran IPA Indonesia (Jppipai)*, *1*(2), 1–6.

[10] Puspitasari, A. D. (2019). Penerapan Media Pembelajaran Fisika Menggunakan Modul Cetak Dan Modul Elektronik Pada Siswa SMA. *JPF (Jurnal Pendidikan Fisika) Universitas Islam Negeri Alauddin Makassar*, *7*(1), 17–25.

[11] Aka, K. A. (2019). Integration Borg & Gall (1983) and Lee & Owen (2004) Models as An Alternative Model of Design-Based Research of Interactive Multimedia in Elementary School. *Journal of Physics: Conference Series*, *1318*(1).

[12] Zed, M. (2008). *Metode Penelitian Kepustakaan*. Yayasan Obor Indonesia.

[13] Mardhiyah, R. H., Aldriani, S. N. F., Chitta, F., & Zulfikar, M. R. (2021). Pentingnya Keterampilan Belajar di Abad 21 sebagai Tuntutan dalam Pengembangan Sumber Daya Manusia. *Lectura : Jurnal Pendidikan*, *12*(1), 29–40.

[14] Yermiandhoko. (2020). *Modul Penyegaran Dosen/Instruktur Pendidikan Profesi Guru Unit 1 Penyusunan Perangkat Pembelajaran*. Direktorat Pendidikan Profesi dan Pembinaan Guru dan Tenaga Kependidikan, Direktorat Jenderal Guru dan Tenaga Kependidikan, Kementerian Pendidikan dan Kebudayaan.

[15] Suwarno. (2013). *Pengembangan Bahan Ajar Materi Applied Approach*. Pusat Pengembangan Kurikulum dan Sumber Belajar LPPMP UNY.

[16] Daryanto. (2013). *Menyusun Modul Bahan Ajar Untuk Persiapan Guru Dalam Mengajar*. Gava Media Dipantara.

[17] Plomp, T., Nieveen, N., Gustafson, K., Branch, R. ., & van den Akker, J. (eds). (1999). *Prototyping to Reach Product Quality*. Kluwer Academic Publisher.

[18] Kurniasih, I., & Sani, B. (2014). *Panduan Membuat Bahan Ajar Buku Teks Pelajaran Sesuai dengan Kurikulum 2013*. Kata Pena.

[19] Prastowo, A. (2013). *Panduan Kreatif Membuat Bahan Ajar Inovatif*. Diva Press.

[20] Larasati, A. D., Lepiyanto, A., Sutanto, A., & Asih, T. (2020). Pengembangan E-Modul Terintegrasi Nilai-Nilai Islam Pada Materi Sistem Respirasi. *Jurnal Penelitian Pendidikan Biolog*, *4*(1), 1–9.

[21] Safitri, A. I., Festiyed, Putra, A., & Mufit, F. (2019). Desain Modul Interaktif Menggunakan Aplikasi Course Lab Berbasis Pendekatan Saintifik pada Materi Usaha, Energi, dan Momentum. *Jurnal Pillar of Physics Education*, *12*(3), 433–440.

[22] Depdiknas. (2008). *Penulisan Modul*. Direktorat Jenderal Peningkatan MutuPendidik & Tenaga Kependidikan Departemen dan Pendidikan Nasional.

[23] Hofstein, A., & Mamlok-Naaman, R. (2007). The Laboratory in Science Education: The State of The Art. *Chemistry Education Research and Practice*, *8*(2), 105–107.

[24] Sani, R. A. (2018). *Pengelolaan Laboratorium IPA Sekolah*. Bumi Aksara.

[25] Dewa, I., Subamia, P., Artawan, P., Wahyuni, I. G. A. N. S., Kimia, J. P., Fisika, J. P., & Mipa, F. (2014). Analisis Kebutuhan Tata Kelola Tata Laksana Laboratorium IPA SMP di Kabupaten Buleleng. *JPI (Jurnal Pendidikan Indonesia)*, *3*(2), 2303–288.

[26] Harefa, D., Ge'e, E., Ndruru, K., Ndruru, M., Dian, L., Ndraha, M., Telaumbanua, T., Sarumaha, M., & Hulu, F. (2021). Pemanfaatan Laboratorium IPA di SMA Negeri 1 Lahusa. *EduMatSains : Jurnal*

Pendidikan, Matematika Dan Sains, *5*(2), 105–122.

[27] Nahdiyaturrahmah, Pujani, N. M., & Selamet, K. (2020). Pengelolaan Laboratorium Ilmu Pengetahuan Alam (IPA) SMP Negeri 2 Singaraja. *Jurnal Pendidikan Dan Pembelajaran Sains Indonesia (JPPSI)*, *3*(2), 118–129.

[28] Ismiyanti, N., Windasari, R., S, A. M., H.M, V., & Aziz, A. (2021). Identifikasi Standarisasi Laboratorium IPA di Salah Satu MTs Jember. *VEKTOR: Jurnal Pendidikan IPA*, *2*(1), 41–48.

[29] Anggereni, S., Suhardiman, S., & Amaliah, R. (2021). Analisis Ketersediaan Peralatan, Bahan Ajar, Administrasi Laboratorium, Keterlaksanaan Kegiatan Praktikum di Laboratorium Fisika. *Jurnal Ilmiah Pendidikan Fisika*, *5*(3), 414.

[30] *Peraturan Menteri Negara Pendayagunaan Aparatur Negara dan Reformasi Birokrasi Tentang Jabatan Fungsional Pranata Laboratorium Pendidikan Dan Angka Kreditnya, 3 (2010).*

[31] Azis, A. A., Pratiwi, A. C., & Yusuf, Y. (2019). Optimasi Management Lab Bagi Guru IPA di Kabupaten Enrekang. *Seminar Nasional Pengabdian Kepada Masyarakat*, 546–548.

[32] Sukariasih, L., Syarifuddin, S., Nursalam, L. O., & Sahara, L. (2020). Validitas dan Kepraktisan Perangkat Pembelajaran IPA Terpadu Berbasis Software Adobe Flash Cs6 pada Tema Energi dan Makanan. *Empiricism Journal*, *1*(2), 96–101.

[33] Sangi, M. S., & Tanauma, A. (2018). Keselamatan Dan Keamanan Laboratorium IPA. *Jurnal MIPA*, *7*(1), 20–24.

[34] Agustina, M. (2018). Peran Laboratorium Ilmu Pengetahuan Alam (IPA) Dalam Pembelajaran IPA Madrasah Ibtidaiyah (MI) / Sekolah Dasar (SD). *At-Ta'dib: Jurnal Ilmiah Prodi Pendidikan Agama Islam*, *Mi*, 1–10.

[35] Nurhayati, N., Zuhra, F., & Septiani, S. (2020). Peningkatan Kompetensi Calon Guru IPA Melalui Pelatihan Pengelolaan Laboratorium. *Journal of Character Education Society*, *3*(3), 679–687.

[36] Isozaki, T. (2017). Laboratory work as a teaching method: A historical case study of the institutionalization of laboratory science in Japan. *Espacio, Tiempo y Educación*, *4*(2), 101.

[37] Raharjo, R. (2017). Pengelolaan Alat Bahan dan Laboratorium Kimia. *Jurnal Kimia Sains Dan Aplikasi*, *20*(2), 99–104.

[38] Gustini, N., & Wulandari, W. (2020). Manajemen Laboratorium Sains Untuk Meningkatkan Mutu Pembelajaran. *Jurnal Isema : Islamic Educational Management*, *5*(2), 231–244.

[39] Hayatun, S., & Abu, N. (2017). *Initial Laboratory Skill of Senior High School ' s Students in Tidore Kepulauan at Chemistry Subject*. *July*, 190–193.

[40] Nurhadi, A. (2018). Manajemen Laboratorium Dalam Upaya Meningkatkan Mutu Pembelajaran. *Tarbawi: Jurnal Keilmuan Manajemen Pendidikan*, *4*(01), 1–12.