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Optimizing Biology Laboratory Management in High Schools: Overcoming Challenges and Exploring Potential

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ABSTRACT
This study aims to identify the quality management of laboratory management in overcoming challenges and exploring student competencies. The research method used is a case study. The research subjects were the principal, vice principal, laboratory head, laboratory assistant, teachers, and students. Data collection was conducted through observation, interviews, literature studies, and documentation studies. The instruments used in this study were observation sheets, interview sheets, and documentation. Based on data analysis and identification, it is known that laboratory management planning in two schools already has a structured activity program. The implementation of laboratory management has facilitated student learning activities and improved student skills. Monitoring/evaluation is carried out once a semester and involves students in the evaluation process. A series of laboratory management optimizations can overcome challenges and explore student potential.

Keywords: Laboratory Quality Management, Student Competency.

I. Introduction

The Quran contains verses demonstrating the importance of laboratories in education. Allah's animals, described in the Quran, can also be used as experimental materials in biology labs. For example, the name of one of the chapters in the Quran, An-Nahl, meaning "the bee," states in verses 68-69:

وَأَوْحَىٰ رَبُّكَ إِلَى ٱلنَّحْلِ أَنِ ٱتَّخِذِى مِنَ ٱلْجِبَالِ بُيُوتًا وَمِنَ ٱلشَّجَرِ وَمِمَّا يَعْرِشُونَ ٦٨

Means "And your Lord revealed to the bees, make nests in the hills, in wooden trees, and in places made by humans, then eat from every (kind of) fruit and walk the path of your Lord which has been made easy (for you)".

The verse above explains that bees can be a medium or tool for thoughtful people to understand the greatness of Allah, which in turn will increase a servant's faith and closeness to Allah

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SWT. The Prophet Muhammad (peace be upon him) also consistently used tools or media, both tangible and intangible, to educate his companions. One of the tools the Prophet used to convey understanding to his companions was images.

As narrated by Imam Ahmad and al-Hakim from Abdullah bin Mas'ud: He said that the Messenger of Allah drew a line for us and said, This is Allah's way. Then drew lines on the right and left, and said, These are (the devil's) paths. Yazid said, (The lines are scattered. Rasulullah SAW said, On every road, a devil is inviting him. Then he read verses from the Koran (QS al-An'am/6: 153)

وَاَنَّ هٰذَا صِرَاطِيْ مُسْتَقِيْمًا فَاتَّبِعُوْهُۚ وَلَا تَتَّبِعُوا السُّبُلَ فَتَفَرَّقَ بِكُمْ عَنْ سَبِيْلِهٖۗ ذٰلِكُمْ وَصّٰىكُمْ بِهٖ لَعَلَّكُمْ تَتَّقُوْنَ ١٥٣

That meaning and that (what We have commanded) is My straight path, so follow it, and do not follow (other) paths, because those paths scatter you from His path. This is what Allah has commanded so that you may be pious. In this hadith, it is clear that Rasulullah SAW used lines as an experimental tool to explain what he wanted to convey to his friends.

With practical activities driven by quality management of laboratory management that is synergistic and runs harmoniously, the education system has implemented the word of ALLAH SWT in the Qur'an, Surah Shad, verse 27.

وَمَا خَلَقْنَا السَّمَاءَ وَالْأَرْضَ وَمَا بَيْنَهُمَا بَاطِلًا ۚ ذَٰلِكَ ظَنُّ الَّذِينَ كَفَرُوا ۚ فَوَيْلٌ لِّلَّذِينَ كَفَرُوا مِنَ النَّارِ

That means "And We did not create the heavens and the earth and what is between them without wisdom. That is the opinion of the disbelievers. So woe to the disbelievers, for they will enter hell". The laboratory in Biology education is an integral part of teaching and learning, where teachers and students conduct experiments and practicals in real life. In Permenpan No. 3 of 2010 Chapter 1 Article 1 it is explained that a laboratory is an academic support unit in an educational institution, in the form of a closed or open room, permanent or mobile, managed systematically for testing, calibration, and/or production activities on a limited scale, using equipment and materials based on specific scientific methods, in the context of implementing education, research, and/or community service.

To optimize the use of biology laboratories as learning resources, optimal quality management is required. According to Deming, quality is conformance to needs. His concept is PDCA (Plan, Do, Check, and Action), which stands for plan, implement, monitor, and improve.Isniah et al (2020) revealed PDCA is a quality management system used as a continuous improvement tool widely used in the service and manufacturing sectors. PDCA activities consist of four steps: Plan, Do, Check, and Action, with repeated stages forming like a circle." Edward Deming developed a quality management system known as PDCA, an acronym for plan, do, check, and act. PDCA is also known as the Shewhart cycle, because the cycle was first discovered by Walter Shewhart (Rachman, 2020).

Quality means the level of excellence of a product in goods or services. In the context of educational quality, it refers to the process or results of education (Djafri & Rahmat, 2017). According to W. Edward Deming, quality is conformance to market or consumer needs. According to Philip B. Crosby, quality is conformance to requirements, which is what is required or standardized. A product is considered high quality if it meets established standards or criteria. These quality standards include raw

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materials, production processes, and finished product(Chaeriah, 2016). Meanwhile, Joseph Juran stated that quality is fitness to meet customer needs and satisfaction. User suitability is based on five main characteristics: technological strength, psychological strength, time reliability, contractual strength, namely the existence of guarantees, and ethics (Juran, 1995).

Management comes from the word to manage, which means to organize. Management has three meanings: management as a process, management as a collective of people who carry out management activities, and management as an art and a science (Marfuah, 2021) According to GR Terry, management is a process consisting of planning, organizing, motivating, implementing and supervising, utilizing both science and art to achieve previously determined goals (Gustini, 2020). The quality of practicum management includes laboratory management, laboratory utilization, planning, and administration. Management within a practicum is crucial; poorly managed practicums can hinder the learning process within the laboratory. Organization and management are carried out through socialization of the rights and obligations of managers in carrying out their duties and responsibilities. With the support of good laboratory quality and practicum management, it is hoped that the practicum will run smoothly(Agustina et al., 2019).

The same thing was expressed by Ricós et al (2004)"developing a system for quality management is essential for proper laboratory organization and continuous improvement". Peniati & Purwantoyo, (2013) Skills in using and managing laboratory equipment and materials are essential to support the success of the learning process. Laboratory management includes coordinating practical activities, scheduling laboratory activities, monitoring implementation, evaluating laboratory activities, and compiling laboratory activity reports. Quality management is an effort to manage a laboratory whose success is determined by interrelated factors (Setyaningrum, 2017). Therefore, researchers are interested in conducting further analysis regarding the optimization of high school biology laboratory management in addressing challenges and exploring potential.

II. Research Method

The approach used in this research is qualitative. The method used in this research is a case study method. This research was conducted at SMA Negeri 1 Pangandaran, West Java, Indonesia. This study collected various data as information in words and documents. This information was obtained from multiple sources: Informants, namely the principal, vice principal, laboratory manager, teachers, and students. Documents, namely written information relating to laboratory management, improve the quality of Biology learning. For example, documents on laboratory profiles, laboratory SOP documents, syllabus, RPP, and learning outcome scores. The object of this research is the Biology laboratory at SMA Negeri 1 Pangandaran, West Java, Indonesia. According to Miles & Huberman (1984), descriptive analysis is carried out through three closely related activity flows. The three activity flows are data reduction, data presentation, and drawing conclusions or verification. From the three flows below, the data is hoped to be meaningful.

III. Result and Discussion

3.1. Findings of the Research

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SMA Negeri 1 Pangandaran comprises the principal, program manager, biology laboratory head, laboratory manager, and biology teacher. The principal is responsible for and supervises the implementation of practicum activities. The laboratory head plans and develops the laboratory. The biology teacher manages activities such as inventory, inspection, and maintenance.

4.1.1. Biology Laboratory Management Planning

4.1.2.

Based on the results of interviews, observations, documentation studies, funding flow for Biology laboratory needs by conducting a check through inventory data and proposed needs until later submitted to the school through the vice principal of curriculum and vice principal of facilities and infrastructure, and after that to the Treasurer. There, it will then be registered and submitted to the principal. Next, the Principal will review and determine the allocation of funds to be used, whether from the RAPBS or the RKAS source of central BOS (School Operational Assistance) funds, adjusted to the level of need for the tools and materials proposed. The following table shows the work program planning for the Biology laboratory at SMA Negeri 1 Pangandaran:

Table 1. Laboratory Activity Program Biology Class of SMA Negeri 1 Pangandaran Academic Year 2022/2023

Work Plan for Achieving Quality Targets	Planning and Implementation Schedule											
	Jul	Aug	Sep	Oct	Nov	Des	Jan	Feb	Mar	Apr	May	June
Checking Laboratory Equipment and Materials												
Creating a Biology Lab Usage Schedule												
Socialization of the Biology Lab Usage Schedule												
Coordinate with all subject teachers regarding the lab usage schedule												
Carry out practical work according to schedule												

4.1.3. Laboratory Facilities and Infrastructure

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Based on interviews with the Laboratory Head and direct observations and field notes, it was discovered that the availability and completeness of laboratory facilities and infrastructure, which are essential for laboratory utilization, did not meet the standards that should be present in a laboratory. The Laboratory Head revealed that some equipment was missing. This was because the laboratory in question had undergone renovations. Lack of maintenance and care for laboratory equipment can hinder the laboratory's ability to conduct experiments or tests that meet established standards. Based on the results of observations, documentation, field notes, and interviews, the biology teacher explained that the equipment and instruments needed in a laboratory depend on the type of experiment being conducted. The laboratory provides Specific equipment and materials, such as measuring cylinders, test tubes, microscopes, and various types of reagents. Based on the results of observations, documentation, field notes, and student interviews, the availability of existing equipment is sufficient in terms of being the initial foundation for learning practicums.

4.1.4. Administration System

Based on the results of observations, documentation, field notes, and interviews, the laboratory head explained that the system can help manage the laboratory's schedule, including practicals, exams, and other activities. This helps avoid overlap and ensures efficient laboratory use. Based on the results of observations, documentation, field notes, and interviews, a laboratory administration system can assist biology teachers in optimizing the management and use of laboratory facilities, enhancing student experience, and supporting efficiency and effectiveness in school learning. A biology teacher explained that planning a laboratory administration system for practicals and experiments is aligned with the material students will be learning.

Based on observations, documentation, field notes, and interviews, students' understanding of the administrative system suggests that borrowing lab coats is permitted on the condition that they return them according to the agreed-upon terms. Likewise, students can borrow laboratory equipment, provided it is not damaged, broken, or missing, and must be returned in the same condition as when borrowed.

4.1.5. Implementation (Do) of Biology Laboratory Management

a. Design and Implementation of Effective Practical Activities

Based on the results of observations, documentation, field notes, and interviews, by implementing this approach, the Principal can ensure that practical activities in the Biology laboratory truly provide opportunities for students to develop a deep understanding of concepts, relevant practical skills, and strong problem-solving abilities. Based on the results of observations, documentation, field notes, and interviews, the laboratory head revealed that the SMAN 1 Pangandaran Biology Laboratory strives to ensure the availability of good facilities and equipment during practical activities. The quality of laboratory facilities and equipment can directly impact the success of practicals and student understanding.

Based on the results of observations, documentation, field notes, and interviews, Biology teachers said that to increase the effectiveness of learning in biology subjects, practical activities can be modified in various ways, for example by adding outdoor observation activities, then combined with

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experimental activities and discussions and then presented in front of the class, or students are assigned to practice independently at home and then documented in the form of videos and uploaded to YouTube and other social media. Based on the documentation results, field notes, and interviews, Students stated that they always adhere to biology laboratory regulations, following the rules and instructions their biology teachers gave. This includes understanding safety procedures, experimental ethics, and handling laboratory equipment. Students also ensure cleanliness and tidiness in the laboratory and conduct experiments according to guidelines. Safety is a priority, and students always wear personal protective equipment.

b. Equipment Maintenance and Care

Based on the results of interviews with the Principal, budget management and resource allocation to identify the need for new equipment, replacement of ineffective equipment, and maintenance of Biology laboratory equipment at SMA N 1 Pangandaran, especially after renovation, are essential steps to ensure that laboratory education runs smoothly and effectively. The principal stated that each year, the vice principal for facilities and infrastructure at the school creates a work plan, which is then outlined in the RKAS (School Activity and Budget Plan). The RKAS is designed in coordination with the school's laboratory heads. The vice principal for facilities and infrastructure collaborates with the laboratory heads to understand the needs and requirements of each laboratory. Based on the results of observations, documentation, field notes, and interviews, the laboratory head is responsible for identifying existing equipment and evaluating the condition of the laboratory, including equipment, devices, and facilities that may require new procurement, repair, or maintenance. After receiving information on laboratory needs, the Vice Principal for Facilities plans the necessary actions. This includes entirely new equipment, replacement of outdated equipment, and routine maintenance.

Based on the results of observations, documentation, field notes, and interviews, the biology teacher explained that in using laboratories during practicals, students' contributions in the care and maintenance of laboratory equipment are essential. Students must understand the importance of caring for and maintaining laboratory equipment. The biology teacher emphasized that students must always ensure that during the practical, laboratory equipment from the beginning to the end remains in good condition to be used in the future. In addition to maintaining it, students are also responsible for cleaning the equipment they use after the practical is completed. Students are given directions on cleaning equipment, starting from washing, cleaning, and drying, to prevent cross-contamination and ensure cleanliness.

Based on the interview results, students expressed that, given a role in the maintenance and care of Biology laboratory equipment, such as after use, the equipment must be washed, cleaned if there is dusty equipment, after use it must be stored in its place, if there is waste in the equipment must be thrown into the trash. This is supported by statements from other students: equipment that has been used must be put back in its place, equipment must be cared for and maintained correctly, and equipment must be used according to the correct provisions. Students are responsible for ensuring that the equipment in the biology laboratory is not damaged.

4.1.6. Evaluation/Monitoring (Check) of Biology Laboratory Management

a. Learning Outcome Data Analysis

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Based on an interview with the Principal of SMA Negeri 1 Pangandaran, the mechanism for evaluating student learning outcomes after biology laboratory activities involves several comprehensive approaches. First, evaluation is conducted by directly observing student participation during laboratory practice. This includes students' active involvement in experiments, ability to use specific tools and techniques, and attitudes toward safety and ethics during practice. Second, written tests or exams can also be part of the evaluation.

Based on the interview results, the laboratory head explained that there are several steps in the evaluation and monitoring mechanism for laboratory management. After rechecking, the cleanliness of the equipment and materials, as well as the safety of the laboratory used, must be considered. This can help prevent cross-contamination between different experiments. Clean equipment will produce more accurate experimental results. The final step is to return the equipment and materials to their original places neatly. Based on the interview results, the biology teacher explains the mechanism for evaluating student learning outcomes after participating in biology laboratory lessons using a comprehensive approach. Student understanding and abilities are assessed through written tests, experimental reports, presentations, and group discussions following the biology lab. Students are asked to explain the processes, concepts, or principles they have learned. Interviews revealed that students were extremely grateful for their achievements in the District-level National Science Olympiad (OSN). Furthermore, they were delighted to see that my learning outcomes had met expectations, as evidenced by the grades they achieved.

b. Resource Usage Monitoring

Based on the interview results, the Principal stated that monitoring the use of resources in the laboratory is very important to ensure efficiency, safety, and quality of laboratory activity programs. In addition, adjustments should be made between the activities carried out in the laboratory and the program that the head of the laboratory has determined. Based on the interview results, the laboratory head explained the monitoring mechanism for resource use to improve the quality of laboratory activity programs. This monitoring is closely monitored by the Vice Principal for Curriculum, who monitors how laboratory resources are used within the curriculum. According to the results of interviews and documentation, several substances that the Principal noted were as follows:

Table 2.Biology Laboratory Supervision of SMA Negeri 1 Pangandaran

Supervised points	Available	Not available
Biology Laboratory Activity Program		
Inventory Book of Tools/Materials		
Biology usage schedule		
Biology Laboratory Activity Diary		
Tool or Material Request Book		
Borrowing or returning card equipment Stock		

Based on the results of observations, documentation, field notes, and interviews, the laboratory head emphasized the importance of designating staff responsible for overseeing the use of laboratory resources. Ensure they clearly understand their roles and responsibilities. Establish a recording and

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inventory system for all laboratory equipment, materials, and resources—record details such as purchase date, condition, and frequency of use. Establish a schedule for laboratory use. This helps avoid overlapping use and ensures that resources are used efficiently. Establish procedures for borrowing equipment or resources. Ensure clear records of who borrowed them, when they were borrowed, and when they were returned.

Based on the interview results, Biology teachers stated that resource use is effective if students can participate in practical learning and master the expected competencies. The effectiveness of data resource use is assessed and measured by distributing questionnaires to students. Teachers monitor how learning objectives in a biology lab or experiment are achieved. Assessment is based on how much students engage in the lab or experiment. Based on observations, documentation, field notes, and interviews, students believed that the laboratory staff had made every effort to facilitate student activities in the laboratory. They provided exceptional support by giving directions, explaining equipment usage in detail, and ensuring safety during experiments.

4.1.7. Follow-up (Action) for Biology Laboratory Management

a. Continuous Improvement

Based on the results of observations, documentation, field notes, and interviews, the principal stated that improvement mechanisms within the institution or school are implemented on a scheduled or routine basis. The basis or guidelines for implementing improvements refer to the School Work Plan and Budget (RKAS). The principal explained that, based on the laboratory activity program evaluation results, a structured and systematic improvement mechanism in the Biology laboratory involves several organized stages. Based on the interview results, the laboratory head explained that structured improvements are situational. He explained that large-scale improvements are a government program, so they often take the initiative to make small-scale improvements for student comfort during labs.

Based on the interview results, Biology teachers demonstrate a crucial approach to improving the effectiveness of laboratory management. Biology teachers use data from formative evaluations (ongoing evaluations that occur throughout the learning process) and summative evaluations (final evaluations that assess student understanding and achievement) to determine the extent to which learning in the biology laboratory has achieved its intended objectives. The findings from these evaluations then inform the design and implementation of changes in laboratory management. This improvement process will be continuously evaluated and adjusted to enhance its effectiveness in supporting student learning. Based on the interview results, the students expressed that the Biology teacher suggested two solutions to address unsatisfactory lab results, namely allowing students to repeat the lab on the same day to correct mistakes, and providing the option for students to join another class's lab to learn from more successful classmates.

b. Realization and Implementation of Practical Development Innovations

Based on the interview results, the Principal of SMA Negeri 1 Pangandaran said that he always provides continuous training and development to teachers and those in charge of the Biology laboratory so that they can create innovative and up-to-date practicums. The principal offers professional development programs for both teachers involved in the laboratory and students. These

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programs include training in ICT support, an understanding of current concepts, and knowledge of the practical applications of cutting-edge ICT-related knowledge..

Based on the interview results, the laboratory head revealed that he had participated in various training programs to implement innovative laboratory development initiatives. He explained that improving student competency was a key focus. This aimed to ensure that laboratory development would provide students with a better understanding of biology and develop relevant practical skills. He acknowledged the importance of ensuring the laboratory activities were engaging for students.

Based on the interview results, Biology teachers emphasize the importance of maintaining continuity and developing biology lab experiments. Teachers must constantly be updated on learning methods used in the laboratory, for example, through YouTube or other online media, to increase student learning interest. Teachers also stated that it is essential to regularly hold FGDs (Focus Group Discussions) with the MGMP (Subject Teachers' Conference) team or with teachers from the same group so that learning methods in the laboratory can continue to develop. This team works together for several purposes, such as brainstorming and generating creative ideas for teaching biology concepts to students. This includes the addition of new technologies or methods.

Based on the interview results, Students reported understanding and applying innovations in biology laboratory experiments to their daily lives. Key points from the students' responses included awareness of the realities of the experiments, intention to use the experiments at home, desire to share experiences with others, and integration of knowledge into real life. Overall, the responses demonstrated students' commitment to maximizing the benefits of their biology laboratory experiences and connecting them to everyday life contexts, indicating a deep understanding and commitment to applying science in their lives.

3.2. Discussion

3.2.1. Biology Laboratory Quality Management Planning to Improve Student Competence

Edward Deming (1986) stated that Planning is an essential management process that clearly defines goals and formulates strategies to achieve them. It is the initial step in the PDCA cycle, which drives continuous improvement in processes and quality. The planning stage involves identifying improvement opportunities and setting priorities to address the causes of problems and proposing solutions. Furthermore, it determines the current state of the analyzed process using consistent data (Vargas et al., 2018).

Findings on the quality management planning of the Biology laboratory at SMA Negeri 1 Pangandaran have been implemented, starting from the planning of infrastructure, activity programs to the procurement of tools and materials, as well as planning for Biology learning and practicum activities from the syllabus, lesson plans, materials to student worksheets that Biology teachers will use have been prepared in advance. The facilities and infrastructure at the school are representative, and the Biology laboratory still refers to the infrastructure standards of the Minister of National Education Regulation No. 24 of 2007.

According to Bafadal (in Nurhadi, 2018), planning school facilities and infrastructure must meet the principles of planning school facilities and infrastructure must be truly an intellectual process, planning is based on needs analysis, planning school facilities and infrastructure must be realistic, by budget reality, visualization of the results of planning school facilities and infrastructure must be clear

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and detailed, both in quantity, type, brand, and price. Planning involves setting goals and implementing the necessary processes to achieve results that align with organizational policies and meet customer needs (Oana & Adelia, 2021).

The planned facilities and infrastructure are part of intellectual interests, especially in the Biology practicum learning. A needs analysis is also carried out by biology teachers based on the curriculum implemented in the school, as well as the reality of the budget, which generally comes from BOS funds, both provincial and central. The results of the planning of facilities and infrastructure are also visualized and detailed in inventory data compiled by the school, by research conducted by Nurhadi (2018) which revealed that planning the management of laboratory facilities and infrastructure in improving the quality of learning in schools must be done by looking at existing needs, both office needs and learning needs. According to Zahara and Agustina (2018), planning is determined carefully from everything that will be implemented, what resources must be provided to support its implementation (human, laboratory materials, equipment, and budget), and activity schedules that include the target time needed to carry out all processes.

According to Edwad Sallis (in Messaoud, 2014), in the operation of Total Quality Management in the world of education several main things need to be considered, including continuous improvement, determining quality standards (Quality Assurance), cultural change (Change of Culture), organizational change (Upside-down Organization), and maintaining relationships with customers (keeping close to the customer). Planning can be seen from the activity program, standard operating procedures, and schedules for using the biology laboratory in schools, which have been prepared and are constantly updated yearly, referring to the standards. This is in line with the opinion of Najemah (2020), who said that planning the use of the biology laboratory can minimize the time conflict between teachers when using the biology laboratory.

3.2.2. Implementation (Do) of Quality Management of Biology Laboratory Management in Improving Student Competence

Implementation is a crucial management function. According to Deming (1986), after the planning process, the next stage in the PDCA cycle is implementation. At this stage, the organization carefully implements the previously prepared improvement or change plans, implementing the steps to achieve predetermined goals. Meanwhile, Tery (in Mulyadi, 2020) states that implementation is the effort of all group members in such a way that they desire and strive hard to achieve goals that align with the planning and organizing efforts of the leadership.

In general, school implementation has been quite good, as evidenced by the alignment of activities with the planned program. However, both schools faced challenges related to human resources (HR) and the availability of biology laboratory facilities. However, these challenges can be overcome by biology teachers who must be more creative in addressing them so that practical activities can still be carried out. Practical activities are also adjusted to the content taught, as not all material can be used for useful work.

Pujiani and Selamet (2020) state that laboratory management includes effective laboratory use, occupational safety, and adherence to regulations. In general, students appear enthusiastic about the practicum activities. Some students already understand the essentials of practicum activities, such as laboratory regulations. The teacher's instructions are clear, enabling students to master the tools and materials used in the practicum. This aligns with Loughran and Hamilton's (2016) study, which found

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that practicums are a place to gain experience. Virtual laboratories can be used to improve students' understanding and thinking skills. To utilize virtual laboratories in learning, teachers must master information technology and the internet (Darby-White et al., 2019).

3.2.3. Evaluation/Monitoring (Check) of Quality Management of Biology Laboratory Management in Improving Student Competence

The principal holds the highest authority in all management aspects, particularly evaluation. Evaluations are conducted twice a year, according to a schedule established in the school program. Indirect/informal supervision is also performed based on reports from the laboratory head. Furthermore, evaluations are also conducted during laboratory learning activities. This ensures that planned activities are achieved. The statement supports this. Evana et al (2021) The principal plays a role in monitoring and evaluating the laboratory's arrangement and storage of tools and materials.

This is supported by Janssen et al (2014) who conducted research on prospective teachers who innovated practical learning in the laboratory, by developing a heuristic learning objective system and teaching impact analysis, the heuristic objective system is a procedure that allows teachers to define current practical activities as a set of lesson segments, then link these segments to a hierarchy of objectives and expected values. Teaching impact analysis allows teachers to compare current lesson segments with lesson segments that represent the target practice framework, to estimate the desirability and probability of each sequence of lesson segments.

3.2.4. Follow-up (Action) of Quality Management of Biology Laboratory Management in Improving Student Competence

According to Deming (1986), follow-up (action) in the PDCA cycle is a series of concrete steps taken after evaluating the results of the steps taken in the Do or implementation phase. The primary focus of this follow-up is to identify factors that cause deviations from the established plan. Therefore, this follow-up involves an in-depth analysis of the differences between expected and actual results. Oana & Adelina (2021:81) state that follow-up consists of achieving continuous improvement in process performance, actively engaging in a series of actions designed to support these improvement efforts. The follow-up to the biology laboratory management, namely the scheduled repairs carried out by the SMA Negeri 1 Pangandaran laboratory with the support of the RKAS Program, demonstrates the school's commitment to maintaining and improving biology laboratory facilities. Through this approach, the school can allocate resources efficiently, ensuring that repairs are carried out systematically and planned. The active involvement of the Vice Principal for Facilities and Infrastructure shows that decisions regarding the biology laboratory not only involve parties directly related to education but also include infrastructure aspects.

The decision-making process regarding the procurement of laboratory materials and equipment at both schools involved school management team meetings, demonstrating a collaborative approach to biology laboratory management. The inclusive decisions provided a broader perspective on needs and necessary improvements. Supported by research by Hartadiyanti et al. (2023), good instructional arrangements must also consider aspects of safety and risk control in the laboratory environment. Providing students with opportunities and repeated demonstrations demonstrates a concern for individual student understanding. This is supported byLeighbody (in Supu et al., 2023:79)

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argues that the assessment of psychomotor learning outcomes includes the ability to use tools and work attitudes, the ability to analyze a job and arrange work sequences, the speed of completing tasks, the ability to read pictures and/or symbols, the harmony of shapes with what is expected and/or the specified size.

This is supported by research by Sari et al. (2023), which states that learning conducted through practical work is effectively used to achieve all domains of knowledge simultaneously, including training so that theory can be applied to real problems (cognitive) and training in independent activity planning (affective). The integration of ICT in practical learning demonstrates an awareness of the importance of technology in increasing the interactivity and effectiveness of learning. The use of smartboards, the creation of YouTube videos of student practical results, the Quizizz application, and PowerPoint media reflect progressive steps towards more modern learning methods. The use of ICT by teachers and students in two schools demonstrates the ability to adapt to technological developments. This increases access to information and creates a dynamic learning environment responsive to students' needs in the digital era. For practical learning to run effectively, technological developments can be another alternative in supporting the implementation of practical work because technological developments increasingly encourage renewal efforts in the learning process (Sari et al., 2023).

5. Conclusion

The quality management of the biology laboratory at SMA Negeri 1 Pangandaran follows the PDCA cycle (Plan-Do-Check-Act) to explore challenges and explore the potential of student competencies. However, it still encounters various obstacles in its implementation. The school implements good biology laboratory management planning, including planning infrastructure, activity programs, procurement of tools and materials, and planning learning and practicum activities. Planning school facilities and infrastructure involves needs analysis, being realistic according to budget, and having a clear visualization. However, maintenance obstacles remain, so many tools are damaged, and materials have expired. Neither school yet has laboratory staff and technicians. In addition, SMA Negeri 1 Pangandaran already has a Laboratory Head who meets the qualification standards.

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