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Management of Utilization of Chemistry Laboratory Based on Instructional Group Classroom to Support the Learning Process

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Abstract

The purpose of this study is to understand the utilization management of the Classroom Instructional Group-based chemistry laboratory and analyse the feasibility of the IGC-based chemical laboratory management engineering guidebook to support the learning process. The chemical laboratory is one type of laboratory that is considered important in the implementation of education, research, and community service so special management is needed. Based on the results of preliminary observations, there are schools that have not utilized the chemistry laboratory to the fullest. Laboratory management is needed so that practical learning in the chemistry laboratory can run effectively. The management of the utilization of this chemical laboratory includes planning, organizing, actuating, and controlling (POAC). This study uses a qualitative descriptive approach to explain the management of the use of IGC-based chemistry laboratories and the 4D (four D) model to analyse the feasibility of IGC-based chemistry laboratory management handbooks to support the learning process. Research data were obtained from the results of observations, interviews, and documentation. The subjects of this study were teachers, laboratory workers, and students. The feasibility level of the IGC-based laboratory management engineering guidebook is determined through 6 product assessment activities, namely from the assessment results of material experts, media experts, peer reviewers, chemistry teachers, laboratory personnel, and student responses. Based on the results of the assessment, it can be concluded that the IGC-based laboratory management engineering guidebook is feasible and suitable for use as a medium to support the student learning process.

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INTRODUCTION

Facilities and infrastructure in an educational institution are facilities that must exist to support the teaching and learning process. The existence of facilities and infrastructure supports the quality of an educational institution. The government provides standards for facilities and infrastructure that must be met for the continuity of the teaching and learning process.

Permendiknas No. 24 of 2007 there are several provisions for facilities and infrastructure for SMA / MA including classrooms, library rooms, biology laboratory rooms, physics laboratory rooms, chemistry laboratory rooms, computer laboratory rooms, language laboratory rooms, leadership rooms, teacher rooms, administrative rooms, places of worship, counseling rooms, UKS rooms, organizational rooms, student affairs, latrines, warehouses, circulation rooms, and playgrounds/sports.

Based on these provisions, it is necessary to highlight the management of chemistry laboratories at the high school / MA level educational institutions because there are still educational units with chemical laboratory management that are still not good.

Laboratory management is a very important activity in schools because it supports the success of the learning process in schools. Chemical laboratory management requires a process, namely planning, organizing, mobilizing, maintaining, and supervising. School laboratory management needs to be carefully planned to support the learning process (Neji et al., 2014; Ijah et al., 2021).

Each subject has a different character from other lessons. Each subject requires different means of learning. Teachers need tools that can support their performance so that learning can take place interestingly. Teachers deliver material in writing, and demonstrations so teachers need a laboratory to support the learning process (Ardestani et al., 2014; Darmawan, 2014).

The importance of infrastructure in learning activities causes a connection between students, teachers, and schools. Students are helped by the support of adequate learning infrastructure. Not all students have a good level of intelligence so that the use of learning infrastructure can help students, especially those who have weaknesses in participating in learning activities. For teachers, it can be helped by the support of infrastructure facilities so that learning activities become more varied, interesting, and meaningful. The school is obliged as a party responsible for the management of all activities organized and is responsible for maintaining the infrastructure that has been owned (Sekerci & Canpolat, 2014; Nuada & Harahap, 2015).

Chemistry is one of the subjects that requires practical activities in the laboratory to meet student competencies. It is not enough if the chemistry is presented in theory only. It is necessary to carry out practicum in a chemistry laboratory that has supporting practicum tools and materials. The purpose of the practicum is to increase knowledge between theory and problem solving with the scientific process.

Laboratories make learning more meaningful because students act directly in observing their experiments. The existence of a chemistry laboratory in high school is a must in modern science education.

Chemical laboratories, of course, need a set of supporting tools. These supporting tools are related to practical tools and materials. There is a need for laboratory management so that the implementation of practicum in the laboratory can run effectively. Good chemical laboratory management requires a manual as a reference to support the learning process.

According to Salirawati (2017) and Serafin and Priest (2015), laboratory management is an effort to manage laboratories based on standard management concepts. Good laboratory management is influenced by several factors. Adequate laboratory equipment, skilled laboratory managers, and good laboratory readiness in each school make teaching and learning activities carried out effectively and efficiently.

Based on the results of initial observations made by researchers, there are still schools that do not have adequate chemical laboratories and

laboratory management that have not been maximized.

Research related to laboratory management has been carried out previously by Sari (2017) who examined the existence of a physics laboratory, knowledge of tools and materials, and work safety in high school laboratories in West Java, but laboratory management which includes planning, organizing, implementing and monitoring has not been explained in detail. In addition, the use of a chemical laboratory management manual does not yet exist, so this research is focused on this aspect.

The formulation of this research problem is related to the management of the use of chemical laboratories based on Instructional Group Classrooms which includes the processes of planning, organizing, implementing, and supervising as well as analyzing the feasibility of the IGC-based chemical laboratory management guidebook to support the learning process. So the purpose of this study is to explain the process of planning, organizing, implementing, and supervising IGC-based chemical laboratories and to analyze the feasibility of IGC-based chemical laboratory management engineering manuals to support the learning process.

This study uses the Instructional Group Classroom (IGC) approach. This approach is because teaching and learning activities are very complex. Teachers, laboratory assistants, and students must work together to achieve the best possible results. Chemical laboratory managers and users must carefully prepare practical activities in the chemistry laboratory so as to prevent managerial problems in the laboratory.

Brian et al. (2007) state that an understanding of chemical laboratory management is very important for laboratory managers and users. The laboratory must be managed and utilized properly because the chemical laboratory is one of the important types of laboratories in the context of implementing education, research, and community service. Good laboratory management is the main goal so that practicum activities can run smoothly. Laboratory managers must have good cooperate and always communicate with other laboratory institutions so that any difficulties can be solved/solved together. Laboratory institutions that do not yet have good abilities and skills must always improve their quality. Quality improvement can be obtained through special skills education, workshops, and internships. So it is expected that chemical laboratory managers can play an active role and be responsible for all operational activities in their laboratories.

According to Koesmadji (2014) laboratory management includes a system for maintaining the smooth use of the laboratory, providing tools and chemicals, and efforts to increase the usability of the laboratory. The maintenance system for the use of the laboratory includes scheduling in the use of the laboratory, the existence of rules to avoid accidents, and the existence of work safety equipment.

All laboratory managers should plan laboratory activities at the end of each year in an effort to prepare to learn for the next academic year so as to improve the quality of learning activities. The use of chemical laboratories is not optimal if it is not supported by adequate tools and materials. Management in the chemistry laboratory is needed to support the smooth running of practicum activities in the laboratory.

Based on this background, Instructional Group Classroom-based chemical laboratory management can be a solution to support the learning process. IGC laboratory management manual can assist laboratory managers and users in managing laboratories according to standards.

METHOD

This study uses a descriptive qualitative approach to explain the management of chemical laboratory utilization based on the Instructional Group Classroom and Research and Development 4D model to analyze the feasibility of an IGC-based laboratory management manual.

This study describes the laboratory management process through objective conditions in the field. The descriptive qualitative research method was used because of several

considerations, namely that adjustments are easier to do when dealing with multiple realities, this method presents a direct relationship between the researcher and the respondent, and this method can adapt to the patterns of values encountered. The R n D method used uses a 4D model (four-D model). The stages of the 4D development model include the define stage, design stage, development stage, and dissemination stage. This method and model were chosen because it aims to produce a product in the form of a chemical laboratory management technique book based on IGC. The product developed is then tested for feasibility by testing the validity and practicality of the product to determine the extent of the response of laboratory personnel, teachers, and students to this product (Bussa & Zalalem, 2015; Ural, 2016).

The research subjects in this study were the managers and users of the chemistry laboratory of SMA/SMK. Informants are expected to provide information about the situation and conditions in the field. The techniques used in data collection in this study were observation, interviews, and documentation. Observation is defined as systematic observation and recording of the symptoms that appear on the object of research. Interviews were conducted by seeking information through conversations with informants. This conversation was carried out by two parties, namely the interviewer who asked the question and the informant who gave the answer to the question. Documentation techniques are taken through documents, photos, and archives which are very useful data to answer problems.

The data analysis used in this research is descriptive qualitative analysis. The qualitative descriptive analysis consists of four interacting components, namely data collection, data reduction, data presentation, drawing conclusions, and verification.

RESULTS AND DISCUSSIONS

The author made initial observations at SMK Muhammadiyah Lasem to find out the actual situation regarding the management of the chemical laboratory in SMK Muhammadiyah Lasem. Observations were made to find out the problems that occur in laboratory management which include the availability of tools and chemicals, student responses to chemistry practicum, chemical materials that must be delivered, and competencies that must be possessed by chemical laboratory managers.

In subsequent observations, the author provides an alternative solution by developing a product in the form of a chemical laboratory management technique manual based on Instructional Group Classrooms to support the learning process. The following are the steps for making a chemical laboratory management engineering manual product based on the Instructional Group Classroom.

The first step is to identify needs and define goals. At this early stage, the author analyzes what is needed by teachers, laboratory assistants, and students in order to complete the learning program in the chemistry laboratory and determine the general goals to be achieved. The second step is syllabus analysis to get the types of tools and materials that must be in the practicum process. The third step is to conduct an instructional analysis, which is to determine the abilities that teachers and laboratory assistants must possess in managing a chemistry laboratory. The fourth step is to determine the job description that must be reached by the chemical laboratory manager. The fifth step is to design and implement the formative evaluation. Formative evaluation is carried out to collect data, identify data, and analyze chemical laboratory management data. The results are to determine whether the application of chemical management has been or not. The sixth step is to design and carry out a summative evaluation. This stage is an advanced stage to see the usefulness of laboratory management after implementation.

This chapter presents the results of research that has been carried out by the author and their discussion. The focus of this research is to explain the Instructional Group Classroom-based chemical laboratory management and analyze the feasibility of the IGC-based chemical

laboratory management technique manual to support the learning process.

Researchers try to find information in the field. The research was carried out in a chemical laboratory at SMK Muhammadiyah Lasem. Sources of initial observations from this study were chemistry subject teachers, laboratory assistants, and students. The data obtained is used to determine the conditions that exist in the field before being studied. Researchers obtained data through observation, interviews, and documentation. From these activities, data were obtained about the chemical laboratory management system at SMK Muhammadiyah Lasem which contains planning, organizing, actualizing, and controlling. The results of the observations can be seen in Table 1 regarding the readiness of laboratory managers.

Table 1. Readiness of Laboratory Managers

Point	Observed aspects	Results
1	There is a location for a chemistry practicum (chemistry laboratory)	1
2	There is a storage warehouse	0
3	There is a storage cupboard	1
4	Inspection of laboratory equipment and materials	0
5	There are adequate lighting facilities	1
6	There is a laboratory staff structure	0
7	There are technicians and laboratories	0
8	Complete chemistry lab equipment	0
9	Equipment and materials are stored separately in separate cabinets	0
IO	There is laboratory equipment such as wall clocks, whiteboards, etc.	1
11	There are safety signs/SOP	0
12	Laboratory room conditions and safety are in good condition	0
13	There are written rules in the laboratory	1
14	Clean laboratory room	0
15	The orderly laboratory administration process	0
16	There is a laboratory management technique manual	0
17	Practical waste can be processed properly	0
Amount		5
Percentage of laboratory readiness (%)		29.41176471
Category (complete/incomplete)		Incomplete

Chemical Laboratory Management

Chemical Laboratory Management at SMK Muhammadiyah Lasem includes several aspects. The aspect studied by the researcher is the system of planning, organizing, implementing, and supervising the chemical laboratory. The chemical laboratory planning system in SMK Muhammadiyah Lasem is still not optimal. This can be seen from the absence of a program specifically designed for the management of chemical laboratories which includes the lack of fulfillment of facilities, tools, and chemicals, the absence of a definite schedule for the use of chemical laboratories, and the availability of inadequate tools and materials.

A good chemical laboratory management planning system starts from planning for laboratory use activities, purchasing systems for chemical equipment and materials, and funding systems. Many chemical tools are quite expensive so purchases can be adjusted according to the ability of the school. According to the laboratory manager of SMK Muhammadiyah Lasem, good chemical laboratory management must cover all aspects, namely regulating, maintaining, and maintaining the safety of its users. The laboratory manager should have a good plan related to chemical laboratory infrastructure which includes the location of the laboratory, the design of the laboratory room, the fulfillment system for laboratory equipment and materials, maintenance, security, and the schedule for the use of the laboratory. The laboratory management must coordinate with the deputy head of infrastructure, school principals, and laboratory personnel.

The chemical laboratory organization system at SMK Muhammadiyah Lasem has not run optimally. The laboratory of SMK Muhammadiyah Lasem does not yet have a clear organizational structure, there are also no laboratory assistants/technicians. The chemistry laboratory should have at least 1 laboratory assistant and 1 technician to assist teachers in carrying out laboratory management. The laboratory of SMK Muhammadiyah Lasem does not yet have a book on borrowing tools and chemicals, does not have an inventory of tools and materials, and does not yet have a manual for chemical laboratory management techniques. In the system of using and borrowing tools and materials in the chemistry laboratory, a material equipment loan card should be used. The loan card must always be available and updated for the sake of orderly administration of the chemistry laboratory. Borrowing or using chemical laboratory equipment outside the laboratory must obtain permission from the chemistry subject teacher, be known by the head of the chemistry laboratory, must bring a tool loan card, and write in the tool loan book. The storage of chemical tools and materials in the chemical laboratory of SMK Muhammadiyah Lasem has not been carried out properly. Chemical tools have not been stored according to their constituent materials, acidic chemicals have not been stored in a fume hood, cleanliness in the laboratory is still lacking, labels on tools and chemicals are not yet complete. The layout of the chemical laboratory at SMK Muhammadiyah Lasem does not yet have good laboratory standards, the school laboratory already has a room for teaching and learning activities but does not yet have a preparation room, warehouse room, dark room, and adequate weighing room. The school laboratory room has double functions, namely a practicum place and a classroom.

The system for implementing the chemical laboratory at SMK Muhammadiyah Lasem has not been running well. The funding system for the chemical laboratory at SMK Muhammadiyah Lasem comes from student fees, funds from schools, and funds from the government. This funding is still very limited and not maximized. The implementation of chemical laboratory rules for the SMK Muhammadiyah Lasem has also not been implemented properly, such as the system for using loan tools, there is no obligation to use a practicum manual, the label attachment system rules, the labels listed are damaged and have not been fixed, some water faucets don't work properly good, the cleanliness of the laboratory is still minimal, the location of the tools and materials that have not been arranged according to the constituent materials, the absence of regulations for waste management, and the absence of rules for the use of practicum coats. The implementation of the fulfillment of tools and practicum materials in the chemical laboratory at SMK Muhammadiyah Lasem has not been carried out at the beginning of the semester. Coordination in data collection of tools and chemicals used for practicum for one semester has not been carried out properly. It should be the task of the head of the laboratory to coordinate with laboratory staff and technicians regarding the stock of tools and materials that have been damaged/out of stock and then coordinate with the principal and the deputy head of the asset department to purchase the tools and materials for the chemical laboratory. The maintenance system for tools and materials in the chemical laboratory of SMK Muhammadiyah Lasem is carried out by cleaning and storing them properly according to their constituent materials. This activity is usually carried out after the practicum, namely by cleaning and storing back the tools and materials that have been used. In addition, maintenance efforts are carried out at the end of each semester and the beginning of the semester by carrying out chemical laboratory cleaning activities which are coordinated by the head of the chemistry laboratory, followed by teachers and students. For the inventory of chemical laboratory equipment and materials at SMK Muhammadiyah Lasem, there is no complete information regarding the overall condition. The schedule for the use of the chemical laboratory at SMK Muhammadiyah Lasem has not been determined with certainty. The implementation of the practicum in the

chemistry laboratory at SMK Muhammadiyah Lasem is only adjusted to the schedule for chemistry subjects at SMK Muhammadiyah Lasem. In addition, the waste generated from the chemistry lab is only disposed of in the trash. There is no specific waste treatment for waste from the lab results from the chemical laboratory of SMK Muhammadiyah Lasem.

The chemical laboratory supervision system at SMK Muhammadiyah Lasem has not been running well. Supervision of the use of the chemical laboratory of SMK Muhammadiyah Lasem needs to be considered. Chemistry practicum must continue even though there is no definite schedule yet. Submission of material and introduction to tools and practicum materials must also be conveyed to students. Laboratory management must be continuously improved. Coordination between laboratory managers, waka sarpras, and laboratory users' needs to be improved. The supervision system is carried out for the safety and security of users in chemical practicum activities. This activity can be seen from the existence of safety support tools in practical activities such as fire extinguishers, gloves, masks, and first aid kits. Supervision for improving the quality of schools also needs to be considered, including supervision of the competence of laboratory managers in the use of tools and materials in the chemical laboratory, a good waste treatment system, and coordination between chemical laboratory managers at SMK Muhammadiyah Lasem.

Constraints experienced and alternative solutions.

Based on the standards of the Regulation of the Minister of National Education Number 24 of 2007 concerning the management of chemical laboratories, there are still several things that must be improved and improved. This activity is needed to improve the quality of the chemical laboratory at SMK Muhammadiyah Lasem. The following are the obstacles in the management of the chemical laboratory at SMK Muhammadiyah Lasem and their alternative solutions.

Lack of funds is an obstacle in laboratory management. From several aspects of chemical laboratory management at SMK Muhammadiyah Lasem, it can be concluded that the funding factor is very important. Limited funds in the management of chemical laboratories are still not optimal. To overcome this funding problem, researchers provide an alternative to seeking additional funding. The alternative way is obtained from the addition of student tuition fees from five thousand to fifteen thousand, besides that this problem can also be anticipated by the existence of products that can be sold from the results of the practicum, such as soap, shampoo, and other practicum products.

The next problem is the less-than-optimal system of planning, organizing, implementing, and monitoring. To obtain maximum results in the management of chemical laboratories, good planning, organization, implementation and supervision are required. The management of the chemical laboratory at SMK Muhammadiyah Lasem must be improved.

The chemistry practicum conducted at the chemistry laboratory of SMK Muhammadiyah Lasem, it produces waste from the results of the practicum. The processing of waste from the practicum has not been managed optimally. Processing of waste from practicum includes separation and handling of waste. The researcher provides an alternative for special waste treatment. Waste management is contained in the Instructional Group Classroom-based chemical laboratory management technique manual which was created by the researcher. This step is an effort to minimize environmental pollution caused by the waste from the practicum.

Chemical equipment and materials in the laboratory of SMK Muhammadiyah Lasem have not met the standards of the Regulation of the Minister of National Education Number 24 of 2007 concerning the management of chemical laboratories. Researchers suggest checking on the condition of the tools and practicum materials regularly and routinely. This activity can be done at the beginning of each semester or the end of the semester.

There is no definite schedule for the use of chemical laboratories which is also an obstacle in laboratory management. The chemistry practicum has indeed been carried out in the laboratory of SMK Muhammadiyah Lasem, but a definite implementation schedule has not been made. For the problem of scheduling the use of the chemistry laboratory, the researcher suggests that the schedule for the use of the laboratory has been determined at the beginning of the new school year, of course with good coordination between the head of the chemistry laboratory. subject teachers, the sarpras section, and the vice principal of the curriculum section.

The next obstacle is there is no determination of chemicals in laboratory practice. For chemicals that are practiced in the laboratory, it has not been determined with certainty and tends to be incidental. In determining the chemistry material to be practiced, it should be determined from the beginning of the semester by the chemistry subject teacher, head of the laboratory, and vice principal of the curriculum section. This activity is carried out as a reference for the fulfillment of tools and materials to be purchased for practicum so that learning becomes more effective.

School resources are still limited. The lack of resources can be seen from the absence of laboratory staff in the chemical laboratory of SMK Muhammadiyah Lasem, this is due to the limited funding system. This can be overcome by seeking additional funding and utilizing skilled students to assist teachers in preparing the tools and chemicals needed during the practicum. Researchers suggest the existence of skilled laboratory workers so that they can assist teachers in preparing tools and chemicals. In addition, in terms of student practicum assessment, pre-test and post-test activities are needed to determine student readiness before practicum and students' understanding after the practicum.

Making an Instructional Group Classroom-Based Instructional Group Classroom Chemical Laboratory Management Guidebook to Support the Learning Process

After knowing the condition of the chemical laboratory at SMK Muhammadiyah Lasem, a solution to the problem of management of the use of the chemical laboratory was carried out, namely the existence of a chemical laboratory management technique manual based on Instructional Group Classroom to support the learning process. The stage of making this chemical laboratory management technique manual refers to a 4D (four D) model consisting of define, design, development, and dissemination stages.

The first stage is to define (define). The define stage starts with the author identifying problems that occur in chemical laboratory management at Muhammadiyah Lasem Vocational School by observing and interviewing teachers, laboratory staff, and several scientific journals and then analyzing the standard components in laboratory management which are used as material in the management technique manual. IGC based chemistry laboratory.

The result of the define stage is to explain field conditions, observe, conduct interviews, and make a needs analysis before designing an IGC-based chemical laboratory management manual.

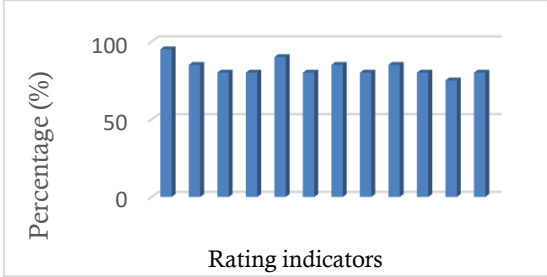
The second phase is the design (design phase). The design stage begins with the author collecting references on IGC-based chemical laboratory management which is used as material for discussion in the book then making a temporary design of the IGC-based chemical laboratory management technique manual. The result of the design stage is a temporary design of a laboratory management technique manual that is adjusted to the results of the needs analysis that has been carried out at the defined stage. The results of the design stage are shown in Figure 1, Figure 2, and Figure 3.

Figure 1. Front Cover of the Guidebook IGC-Based Chemical Laboratory Management

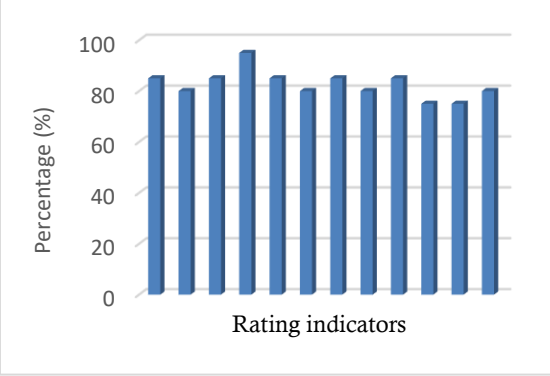
Figure 2. Front Cover Design

Figure 3. Side Cover Design

The third phase is development (development stage). The development stage starts with the author making a chemical laboratory management guidebook based on IGC. At the development stage, the researcher began to make a chemical laboratory management engineering manual product according to the initial design that had been planned then consulted and validated the initial draft of the chemical laboratory management book that had been prepared to expert lecturers to provide revisions and input so that it was suitable for use in chemical laboratory management activities. At this stage, the results of the initial product manual for chemical laboratory management techniques based on IGC were communicated, revised, and validated by 5 material expert lecturers and media experts. The results of validation by material experts in Graph 1 and the results of validation by media experts are presented in Graph 2.



Graph 1. Expert Validation Results

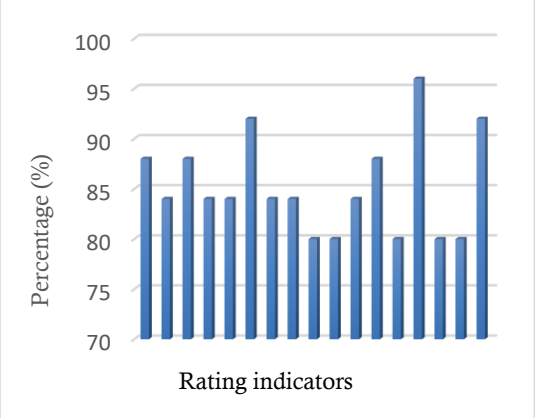


Graph 2. Media Expert Validation Results

Validation from material experts and media experts in the IGC-based laboratory management technique manual was used to validate the content in the media that had been developed. Validation carried out by material experts and media experts is to collect suggestions for improvement. Assessment by

material experts obtained a total score of 199 and a percentage value of 82.9%. The material in this media is said to be suitable for use. Assessment by media experts obtained a total score of 198 and a percentage value of 82.5%. This media is said to be feasible to use.

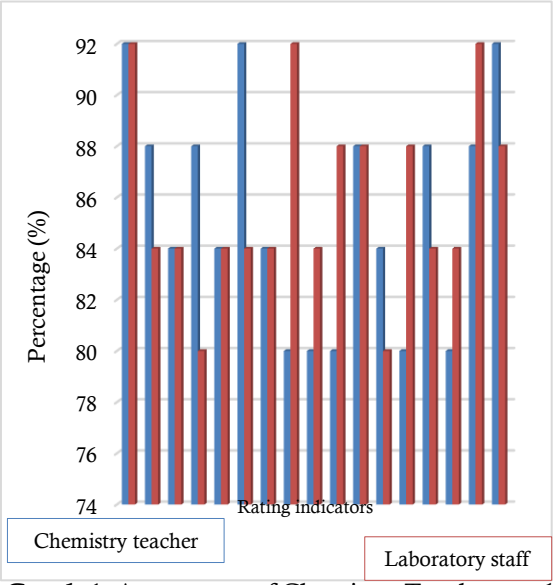
After that, the researchers consulted the chemical laboratory management book which had been revised by the supervisor to the peer reviewers (five graduates of chemical/chemical engineering/pure chemistry education who had attended the instrument training program or had received MSDS courses or five students of educational management who were experts in their fields) to provide revisions and feedback. The results of the assessment from Peer Reviewers obtained an average score of 362 and a percentage value of 85.1% and is said to be feasible as a learning medium. The score results from peer reviewers are presented in Graph 3.



Graph 3. Assessment Results From Peer Reviewers

The fourth phase is dissemination (dissemination stage). The dissemination stage begins with the authors conducting a feasibility study of laboratory management books for chemistry teachers, laboratory assistants, and students at educational institutions at the SMA/MA/SMK level then they respond to the quality of the IGC-based chemical laboratory management manual. Feasibility tests are carried out to assess the suitability, practicality, validity, advantages, and disadvantages of the product. If the assessment of the quality of the chemical laboratory management manual is still not good or very bad, then it is revised again to produce a chemical laboratory management manual of good/excellent quality (Barlag et al., 2014; Berry et al, 2016).

Respondents were taken from 5 chemistry teachers and 5 laboratory assistants. Assessment is used to collect suggestions and then make improvements. Furthermore, books that are in accordance with the suggestions are distributed to their respective schools to be used as media to support the learning process. The results of the assessment of the chemistry teacher obtained a score of 363 and a percentage value of 85.4% which is said to be feasible as a learning medium. The results of the assessment of the laboratory staff obtained a score of 365 and a percentage value of 85.8% which is said to be feasible as a learning medium. The results of the responses from the chemistry teacher and laboratory staff are presented in Graph 4.

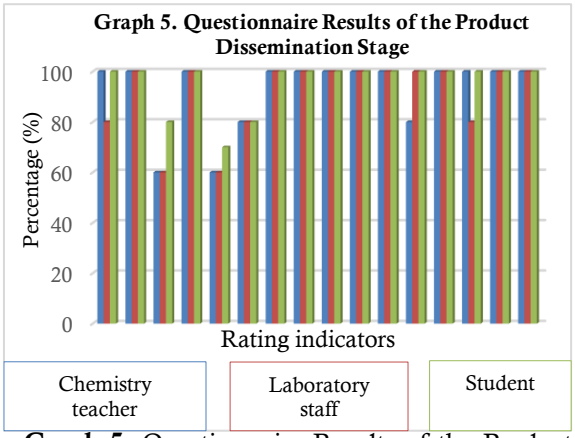


Graph 4. Assessment of Chemistry Teachers and Labs

The large-scale dissemination stage of product development of IGC-based laboratory management guidebooks was taken from the responses of chemistry teachers, laboratory assistants, and students to the IGC-based chemical laboratory management manual. The assessment instrument for the guidebook is in the form of a student questionnaire. Respondents

were taken from 5 chemistry teachers, 5 laboratory assistants, and 10 students.

The results of the assessment of the chemistry teacher obtained a score of 74 and a percentage value of 92.5% and are said to be feasible as a learning medium. The results of the laboratory assessment obtained a score of 73 and a percentage value of 91.2% and are said to be feasible as a learning medium. The results of the assessment from students obtained a score of 153 and a percentage value of 95.6% and were said to be feasible as a learning medium. The results of the responses are presented in Graph 5.



Graph 5. Questionnaire Results of the Product Dissemination Stage

Research Limitations

The following are the limitations of research during the process of developing an IGC-based laboratory management manual, namely product socialization is only limited to 1 school, namely SMK Muhammadiyah Lasem, respondents from teachers, laboratory assistants, and reviewers are still limited, research is still focused on testing the validity and practicality of products using research methods research and development 4d and has not yet arrived at testing the effectiveness of using IGC-based laboratory management technique manuals in improving student competence.

CONCLUSION

Based on the results of research and development of IGC-based technical manuals for chemical laboratory management, researchers can draw conclusions from this research that is-based laboratory management techniques manuals have been produced. The product is developed using a 4d model by going through 4 stages of the development model. These steps include defining design, development, and dissemination stages.

The feasibility level of the IGC-based laboratory management technique manual is determined through 6 product assessment activities, namely the results of the assessment of material experts, media experts, peer reviewers, chemistry teachers, laboratory officers, and student responses. The results of the assessment carried out by material experts obtained a feasibility level of 82.9% in the appropriate category. The results of the research by media experts obtained a feasibility level of 82.5% in the appropriate category. The results of the peer reviewer's assessment obtained a feasibility level of 85.1% in the appropriate category. The results of the chemistry teacher assessment obtained a feasibility level of 85.4% in the appropriate category. The results of the assessment from laboratory personnel obtained a feasibility level of 85.8% in the appropriate category.

In the large-scale socialization stage, the product of the chemistry teacher's assessment obtained a feasibility assessment of 92.5% in the appropriate category. The results of the assessment from laboratory officers obtained a feasibility assessment of 91.25% in the appropriate category. The results of the student response assessment obtained a feasibility level of 95.6% in the appropriate category. Based on the results of the assessment, it can be concluded that the IGC-based laboratory management technique manual is feasible and appropriate to be used as a medium to support the student learning process. This research result is supported by Prabha (2016) and Darsana et al. (2014) who state that the IGC-based laboratory management technique manual is feasible and appropriate to be used as a medium to support the student learning process.

Based on the results of the research and the conclusions above, the following are some suggestions that can be given by researchers,

namely the need for further development of guidebooks related to the addition of MSDM material, it is necessary to test the effectiveness of using technical guidelines for managing IGC-based chemical laboratories, so that it is known how much influence the module has on improving student competence. IGC-based chemical laboratory management technical manuals that have been developed should be copyrighted.

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