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Literature Analysis on High School Chemistry Practicum Methods: A Comparative Study of Video-Based Demonstration Approach and Student Worksheets in the Formation of Scientific Attitudes

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ABSTRACT

Objective: *The study aims to evaluate the characteristics, advantages, and disadvantages of each approach, as well as identify their impact on the development of students' scientific attitudes, such as curiosity, rigor, critical thinking, and scientific responsibility.* ***Method:*** *This study is a literature analysis that compares two approaches in chemistry practicum at the high school level, namely video-based demonstrations and the use of Student Worksheets (LKS), in relation to the formation of scientific attitudes.* ***Results:*** *The analysis showed that the video approach excelled in visualization and learning efficiency, while the LKS was more effective in developing procedural skills and scientific attitudes based on hands-on experience. The integration of the two approaches is considered capable of creating a holistic learning experience, especially in the context of inquiry-based learning. This research also emphasizes the importance of the teacher's role as a facilitator in managing adaptive practicum, as well as the need for instructional design that encourages students' independent reflection and exploration.* ***Novelty:*** *These findings are expected to be the basis for the development of innovative and contextualized chemistry learning methods, as well as supporting educational policies that lead to more effective and meaningful science learning.*

INTRODUCTION

Chemistry learning at the Senior High School (SMA) level has complex characteristics because it involves abstract concepts, microscopic representations, and practical skills [1]. Practicum as an integral part of chemistry learning plays an important role in building students' comprehensive understanding and science process skills. However, the implementation of chemistry practicum in Indonesia still faces various obstacles, including limited laboratory facilities, availability of chemicals, and efficiency of learning time. On the other hand, the development of information technology has opened up opportunities for innovation in practicum learning through digital-based approaches such as video demonstrations. Conventional chemistry practicum is generally guided by Student Worksheets (LKS) as an instrument that has long been used in science learning. LKS provides procedural guidance and stimulation of scientific observations that help students carry out experiments. Meanwhile, the video-based demonstration approach has developed as an alternative or complement to conventional practicum, especially in situations of limited facilities or to provide visualization of chemical processes that are difficult to observe directly.

Scientific attitude is one of the important components in science learning that includes aspects of curiosity, objectivity, critical, open, honest, and skeptical of observations. The formation of scientific attitudes is an essential goal of chemistry learning at the high school level, and the practicum method is one of the effective approaches in fostering these attitudes [2]. Various studies have shown that different learning methods can have varying effects on the development of students' scientific attitudes. In the context of modern chemistry learning, the debate on the effectiveness of various practicum approaches is still ongoing. Some educators argue that hands-on practicum guided by worksheets provides an authentic experience that is irreplaceable in the formation of scientific attitudes. On the other hand, technology-based approaches such as video demonstrations offer advantages in terms of access, efficiency, and visualization of concepts that are difficult to observe. The different characteristics of these two approaches need to be studied in depth to understand how each method can influence the formation of scientific attitudes in learners.

A comprehensive literature analysis of the two approaches is important to provide an empirical and theoretical basis for teachers and educational practitioners in choosing and designing effective practicum methods [3]. This comparative study will examine various previous research results regarding the use of video-based demonstrations and LKS in chemistry practicum, focusing on their impact on the formation of scientific attitudes of high school students. The development of the digitalization era of education has significantly changed the learning paradigm of chemistry practicum. The video-based demonstration approach offers the potential to overcome the inequality of access to laboratory facilities which is still a problem in various schools, especially in remote areas. Through video demonstrations, students can observe experimental procedures performed with standard equipment and chemicals that may not be available in their schools. This phenomenon becomes even more relevant in the context of Indonesian education, which has a wide gap in educational infrastructure between urban and rural areas.

The implementation of the Merdeka Curriculum also provides wider space for teachers to develop learning methods that are varied and adaptive to student needs [4]. Chemistry practicum, as a key element in experiential learning, needs to be redesigned to meet the demands of 21st century competencies that emphasize critical thinking skills, collaboration, communication, and creativity. The video-based demonstration approach and the use of structured LKS each have strengths that can be utilized to develop these aspects of competence, with a different emphasis on each method. Scientific attitudes formed through practicum activities not only affect students' academic achievement in chemistry subjects, but also have an impact on their character development and readiness to face future challenges. In the context of the industrial revolution 4.0, the ability to think systematically, objectively, and critically is a highly valued qualification in the world of work. Therefore, evaluation of practicum methods that can effectively foster scientific attitudes is strategic not only from a pedagogical point of view but also in the broader perspective of human resource development.

Various preliminary studies on chemistry practicum in Indonesia show that there is still a gap between practice in the field and the theoretical ideal. Many practicum activities are still verification and do not provide enough space for students to develop creative thinking and scientific inquiry skills [5]. Both the video-based demonstration approach and the use of LKS need to be evaluated in their ability to transform the verification practicum into an inquiry-based laboratory. This transformation is important to foster authentic scientific attitudes, not just following predetermined procedures.

Based on the above background, the problem formulation in this study focuses on an in-depth study of the characteristics and effectiveness of two approaches to chemistry practicum in the context of high school education. This study seeks to reveal how the characteristics of the video-based demonstration approach and the Student Worksheet (LKS) based approach are implemented in high school chemistry practicum, as well as how each approach affects the formation of students' scientific attitudes. The study also sought to analyze the comparative effectiveness of the two approaches in fostering students' scientific attitudes, taking into account varied learning contexts and conditions. Furthermore, this study identifies key factors that influence the successful implementation of the two approaches, including pedagogical, technological, and practical aspects that need to be considered to optimize the process of scientific attitude formation through chemistry practicum activities at the high school level.

This research aims to comprehensively explore the characteristics of the video-based demonstration approach and the Student Worksheet-based approach in the context of high school chemistry practicum, with an emphasis on the fundamental aspects that distinguish the two from a pedagogical and implementative perspective. Through a systematic literature analysis, the study will examine how the two approaches influence the process of students' scientific attitude formation, taking into account various dimensions of scientific attitudes including curiosity, objectivity, critical thinking skills, and healthy skepticism. The study is also geared towards critically comparing the effectiveness of the two approaches in diverse contexts, as well as identifying the conditional factors that influence their successful implementation. By integrating empirical and theoretical findings from various sources, this study aims to provide a comprehensive information foundation for evidence-based decision-making in the development and implementation of optimal chemistry practicum methods.

This study offers significant contributions in both theoretical and practical dimensions. Theoretically, this study enriches the corpus of knowledge in the field of chemistry education by providing an in-depth analysis of practicum approaches in the formation of scientific attitudes, developing a conceptual framework that can be used to evaluate practicum learning methods, and expanding the understanding of technology integration in experimental science learning. In practical aspects, the results of this study provide multidimensional benefits for various stakeholders in the educational ecosystem. For chemistry teachers, this study provides evidence-based information that can guide the selection of practicum methods that suit specific learning contexts and offer optimization strategies for both video-based and LKS-based approaches. For educational institutions, the research findings can be a reference in developing laboratory resource allocation policies and improving the quality of practicum learning amid various limitations. Curriculum developers can utilize the results of this study as input to design a chemistry curriculum that integrates technology effectively and pays attention to aspects of scientific attitude formation. As for the educational research community, this study provides a foundation for further research and identifies knowledge gaps that need to be further explored in an effort to promote innovative and effective chemistry practicum methods.

The Nature of Chemistry Learning in High School

Chemistry learning at the high school level is a process that integrates understanding of concepts, practical skills, and development of scientific attitudes [6]. Chemistry has characteristics that involve understanding phenomena at three levels of representation: macroscopic (directly observable), submicroscopic (atoms and molecules), and symbolic (formulas and equations). The main difficulty for high school students in understanding chemistry is to connect these three levels of representation meaningfully. Effective chemistry learning not only emphasizes mastery of concepts, but also the development of science process skills and scientific attitudes. The high school chemistry curriculum in Indonesia is designed to form students who have good science literacy, are able to apply chemical knowledge in everyday life, and have the higher order thinking skills needed to face future challenges.

Practicum in Chemistry Learning

Practicum is an integral part of chemistry learning that serves as a means to verify concepts, build new knowledge, and develop science process skills [7]. Through practicum activities, students have the opportunity to make direct observations of chemical phenomena, collect and analyze data, and draw conclusions based on the empirical evidence they obtain. There are several types of practicum in chemistry learning, ranging from verification practicum (proving concepts that have been learned), exploratory practicum (investigating phenomena without clear initial concepts), to inquiry-based practicum (formulating and testing hypotheses). Each type of practicum has advantages and limitations in the context of learning at the high school level, and has a different influence on the formation of students' scientific attitudes. Chemistry practicum in high school faces various implementation challenges, including limited time, laboratory facilities, safety, and cost efficiency. This encourages the development of various alternative approaches in practicum implementation, including the use of video-based demonstrations and structured student worksheets.

Scientific Attitudes in Science Learning

Scientific attitude refers to a set of mental dispositions that characterize a scientist in conducting investigations [8]. The components of scientific attitudes include curiosity, honesty, objectivity, criticality, openness to new ideas, skepticism, and perseverance. The development of scientific attitudes is one of the important goals in science education, including chemistry, because these attitudes are not only useful in academic contexts but also in everyday life. Scientific attitudes are not formed instantly, but through a process of habituation and direct experience in scientific activities. Chemistry practicum provides opportunities for students to develop scientific attitudes through an inquiry process that involves observation, asking questions, formulating hypotheses, collecting data, and drawing conclusions based on evidence. Measurement of scientific attitudes can be done through various methods, such as behavioral observations, questionnaires, interviews, and analysis of student practicum reports. In the context of educational research, understanding scientific attitudes and the factors that influence their formation is important for developing effective learning approaches.

Video-based Demonstration Approach in Chemistry Practicum

Video-based demonstration is a learning approach that utilizes audiovisual media to display chemical procedures and phenomena to students [9]. This approach allows visualization of chemical processes that are complex, dangerous, or difficult to observe in school laboratory conditions. Video demonstrations can serve as a substitute or complement to hands-on practicum activities, especially in situations of limited facilities and infrastructure. The main characteristics of the video-based demonstration approach include clear visualization, control over the playback rate, the possibility of repetition, and the integration of multimedia elements (sound, text, animation) that can enhance student understanding. This approach also offers advantages in terms of time efficiency, standardization of the learning experience, and safety. In the context of scientific attitude formation, the video-based demonstration approach has advantages in terms of facilitating detailed observation, fostering curiosity, and stimulating critical thinking. However, it also has limitations in developing manipulative skills and direct sensory experiences that are important in chemistry learning.

Student Worksheet Approach in Chemistry Practicum

Student Worksheet (LKS) is a learning instrument in the form of a structured guide that helps students carry out practical activities independently or in groups [10]. LKS in chemistry practicum usually contains objectives, basic concepts, tools and materials, work procedures, observation tables, analysis questions, and conclusions. The LKS serves as a guide that helps students understand the purpose of the practicum, follow the procedure correctly, and organize the results of observations systematically. The main characteristics of the LKS-based approach are a clear structure, systematic stages, and integration between practical activities and cognitive processes. LKS can be designed with various levels of openness, ranging from very structured (cookbook) to very open (open inquiry), depending on the learning objectives and the level of student independence. In the context of scientific attitude formation, the LKS-based approach can encourage accuracy, discipline, honesty in data collection, and analytical skills. A well-designed worksheet can also stimulate curiosity and critical thinking through challenging questions. However, this approach also has limitations, especially if the worksheet is too structured, limiting students' creativity and independence of thought.

Comparison of Video-based Demonstration Approach and LKS

The video-based demonstration approach and the worksheet-based approach have different characteristics in the context of chemistry practicum. In terms of student engagement, the worksheet-based approach generally provides a more intensive hands-on experience, while the video-based demonstration approach emphasizes visual observation. In terms of flexibility, video demonstrations offer ease of access and the possibility of repetition, while worksheets provide structured guidance that can be adapted to students' learning pace. The two approaches have different implications for the formation of scientific attitudes. The video-based demonstration approach tends to be more effective in developing detailed observation and mental visualization skills, while the worksheet-based approach supports the development of independence, responsibility and experimental skills. The combination of these two approaches has the potential to complement each other and provide a comprehensive learning experience. Factors that influence the effectiveness of both approaches include the characteristics of the subject matter, availability of facilities and infrastructure, teacher competence, and student learning styles. In the context of Indonesian chemistry education, choosing the right approach needs to consider the real conditions in the field and the learning objectives to be achieved.

Learning Theories Underlying Chemistry Practicum

Some learning theories that are relevant in the context of chemistry practicum include constructivism, information processing theory, and experiential learning theory. Constructivism theory emphasizes that knowledge is actively constructed by students through interaction with the environment and direct experience. In this context, both the video-based demonstration approach and LKS can be a means to facilitate the knowledge construction process, albeit in different ways. Information processing theory provides a view of how information is received, processed and stored in students' memory. The video-based demonstration approach offers strong visual stimulation, while the worksheet-based approach provides a multisensory experience that involves various information processing channels. The experiential learning theory developed by Kolb describes learning as a cycle involving concrete experience, reflective observation, abstract conceptualization, and active experimentation. The two practicum approaches discussed have strengths at different stages in this learning cycle, so their combination has the potential to create a more holistic learning experience.

Technology Development and its Implication in Chemistry Practicum

Advances in information and communication technology have opened up new opportunities in the implementation of chemistry practicum. In addition to video demonstrations, various technologies such as virtual laboratories, interactive simulations, and augmented reality have also begun to be integrated in chemistry learning. These technologies offer dynamic visualization of submicroscopic phenomena, which are difficult to access through conventional practicum. In the digital era, a paradigm shift has also occurred in the design of worksheets, from conventional printed formats to more interactive digital formats. Digital worksheets can be equipped with multimedia elements, links to additional learning resources, and interactive features that enrich students' learning experience. The integration of technology in chemistry practicum needs to consider the balance between ease of access, depth of learning experience, and the goal of forming scientific attitudes. Technological developments should not merely replace direct experience, but enrich and complement existing learning approaches.

RESEARCH METHOD

Research Design

This study used a qualitative approach with a library research method to comprehensively review the literature related to high school chemistry practicum methods, especially those comparing video-based demonstration approaches and the use of Student Worksheets (LKS) in the formation of scientific attitudes. The qualitative approach was chosen because it allows in-depth exploration of the various dimensions and nuances of the two practicum methods, as well as providing space for contextual interpretation of previous research findings. The literature study method was carried out systematically through the collection, identification, analysis, and synthesis of relevant literature to build a comprehensive understanding of the characteristics, implementation, and impact of the two practicum approaches on the formation of scientific attitudes of high school students.

Data Source

The data sources in this study consist of primary and secondary literature published within the last 10 years (2014-2024) to ensure the relevance of the findings to the contemporary educational context. Primary data sources include national and international scientific journal articles indexed in reputable databases such as Scopus, Web of Science, SINTA, ERIC, Science Direct, and Google Scholar. In addition, this study also used scientific conference proceedings, dissertations, and theses relevant to the research topic. Secondary data sources include textbooks, research reports, educational policy documents, and publications from educational institutions or professional organizations related to chemistry practicum, video-based learning, and the use of LKS. Inclusion criteria for data sources included: (1) publications that specifically address high school chemistry practicum or equivalent, (2) empirical studies or theoretical studies on the use of video demonstrations and/or worksheets in chemistry learning, and (3) studies that measure or examine aspects of scientific attitudes in the context of science learning. Data sources in Indonesian and English were used to enrich perspectives and ensure representation of national and global educational contexts.

Data Collection Technique

Data collection techniques in this study were carried out through systematic literature searches using relevant keywords and their combinations, both in Indonesian and English. The keywords used include: "chemistry practicum", "chemistry video demonstration", "chemistry student worksheet", "scientific attitude", "chemistry laboratory work", "video-based chemistry demonstration", "student worksheet chemistry", and "scientific attitude". Searches were conducted on various electronic databases and physical libraries to ensure comprehensive coverage. To organize the literature obtained, researchers used Mendeley reference management software that allows for efficient categorization, annotation, and tracking of sources. Each data source collected was then verified for quality and relevance through checking its publication status, research methodology, and suitability to the focus of this study. The complete bibliographic data of each source was systematically recorded, including information on the author, year of publication, title, source of publication, methodology, research sample (if any), and key findings relevant to the research objectives.

Data Analysis Technique

Data analysis in this study was conducted using a qualitative content analysis approach that is interpretative and comparative in nature. The analysis process followed five main stages: First, the researcher conducted a close reading of each source to gain a general understanding of the content and context. Secondly, the coding process was carried out on relevant information based on the research conceptual framework which included aspects of practicum approach characteristics, implementation, pedagogical implications, and impact on scientific attitudes. Third, the researcher identified patterns, trends, similarities, and differences that emerged from various sources through the constant comparative analysis method. Fourth, the findings were organized into thematic categories related to the formulation of the research problem. Fifth, the researcher conducted an interpretive synthesis to develop a coherent and comprehensive narrative of the phenomenon studied. In the comparative analysis stage, the researcher used a systematic mapping approach to map the characteristics and effectiveness of the two practicum methods in various learning contexts. A source triangulation process was implemented to ensure the validity of the findings, by comparing perspectives from different types of publications and different theoretical backgrounds.

Analysis Framework

The analysis in this study was based on a conceptual framework consisting of four main dimensions: (1) Instructional characteristics, which include aspects of learning design, activity structure, and teacher-student roles in each practicum approach; (2) Technological and accessibility aspects, which address the required infrastructure, affordability, and flexibility of implementation; (3) Learning processes, which focus on students' learning experiences, the cognitive processes involved, and the interactions between students and learning materials; and (4) Learning outcomes, specifically related to the formation of scientific attitude components such as curiosity, objectivity, critical thinking, and skepticism. This framework enables a systematic and comprehensive analysis of the relevant literature and facilitates a multidimensional comparison between the video-based demonstration approach and the LKS-based approach in the context of high school chemistry practicum.

Research Validity and Credibility

To ensure the validity and credibility of the findings, this study implemented several strategies. First, the researcher applied strict selection criteria to the data sources to ensure the quality and relevance of the literature analyzed. Second, source triangulation was conducted by comparing findings from different types of publications, geographical contexts and theoretical frameworks. Third, the analysis is presented with a high degree of transparency, including explicit explanations of the data collection process, selection criteria, and analysis methods. Fourth, interpretations of findings are accompanied by sufficient textual evidence from original sources to enable verification by readers. Fifth, the researcher explicitly identifies limitations in literature coverage and knowledge gaps discovered during the review process. Through the application of these strategies, the research aims to produce a comprehensive, balanced and reliable analysis of the topic under review.

Research Procedure

This research was conducted through a series of systematic stages. The first stage was the formulation of the problem and the development of a conceptual framework that became the basis for the literature search. The second stage was the search and collection of relevant literature from various sources using predetermined keywords. The third stage involved screening and selecting sources based on predetermined inclusion and exclusion criteria. The fourth stage was systematic data extraction from the selected sources, including bibliographic, methodological information and key findings. The fifth stage involved analyzing and synthesizing the data using qualitative content analysis methods and a constant comparison approach. The sixth stage is organizing the findings into a coherent thematic framework in accordance with the formulation of the research problem. The final stage was drawing conclusions, implications and recommendations based on the results of the analysis. The entire research process was systematically documented to ensure transparency and possible replication by other researchers in the future.

Research Ethics

Although this research did not involve direct human participants, the researcher still upheld academic ethical standards in conducting the literature study. The ethical aspects considered include: (1) proper recognition of the authors' intellectual work through accurate citation and referencing, (2) avoidance of plagiarism in all its forms, (3) fair and balanced representation of the various perspectives and findings found in the literature, (4) transparency in reporting the research process and basis for interpretation, and (5) caution in drawing conclusions, especially when empirical evidence is insufficient or ambiguous. By adhering to these ethical principles, the research aims to make a meaningful and responsible contribution to knowledge in the field of chemistry education.

RESULTS AND DISCUSSION

Characteristics of Video-Based Demonstration Approach in High School Chemistry Practicum

Based on a comprehensive literature analysis, the video-based demonstration approach in high school chemistry practicum shows several distinctive characteristics that distinguish it from conventional practicum methods. The main characteristics identified include visualization of microscopic phenomena, standardization of learning experiences, flexibility of access, and integration of multimedia elements [11]. In the context of visualization, demonstration videos allow observation of chemical reactions that are complex, dangerous, or require special equipment that is not always available in school laboratories. This approach facilitates detailed visualization of submicroscopic phenomena that are difficult to observe directly, such as molecular movement, crystal structure changes, and reaction mechanisms at the molecular level. The ability to slow down, pause or repeat the show also provides an opportunity for students to observe important details that may be missed in a live demonstration. The second salient characteristic of the video-based demonstration approach is its ability to provide a standardized learning experience. The analysis shows that video demonstrations minimize variability in the execution of experiments, so that all students get identical exposure to chemical procedures and phenomena. This is in contrast to conventional lab work, which often results in varied learning experiences between student groups due to differences in manipulative skills or experimental conditions. Furthermore, the video-based approach offers flexibility of access that allows students to learn without time and place constraints. The integration of multimedia elements such as animation, graphics, audio narration, and explanatory text in demonstration videos creates a multisensory learning experience that supports the understanding of complex chemical concepts through multiple learning modalities.

Characteristics of Student Worksheet-Based Approach in High School Chemistry Practicum

The Student Worksheet-based approach in high school chemistry practicum has different characteristics compared to video-based demonstrations. The analysis identified several main characteristics, including an organized procedural structure, hands-on experience, cognitive scaffolding, and systematic documentation [12]. LKS provides a clear structure for students to conduct experiments, starting from the objectives of the practicum, a list of tools and materials, detailed work procedures, to the format of data collection and analysis. This structure provides a framework that helps students to carry out the practicum independently or in small groups, while ensuring that all the important stages of scientific inquiry are systematically followed. The most prominent characteristic of the LKS-based approach is its emphasis on hands-on experience in the manipulation of chemical tools and materials. Through physical interaction with objects of study, students develop psychomotor skills, procedural understanding, and sensitivity to chemical phenomena that cannot be fully facilitated by digital mediums. In addition, the LKS also functions as cognitive scaffolding that guides students' thinking processes through leading questions, detailed instructions, and a framework for organizing observations. Systematic documentation in the form of observation tables, graphs, and analysis questions help students to develop the skills of accurate data recording and effective organization of experimental information, which are essential components of the scientific process.

The Effect of Video-Based Demonstration Approach on the Formation of Scientific Attitude

Analysis of various studies shows that the video-based demonstration approach has a significant influence on several dimensions of students' scientific attitudes in learning high school chemistry [13]. The most positively affected aspects of scientific attitudes are curiosity, observation skills, and critical thinking. A well-designed demonstration video is able to stimulate students' curiosity through visualization of interesting phenomena and presentation of contextual problems. When students observe chemistry experiments through videos, they often develop deep questions about "why" and "how" a phenomenon can occur, which are important indicators of an inquisitive attitude in a scientific context. In the dimension of observation skills, the video-based demonstration approach allows students to focus on important details in chemical processes without being distracted by technical difficulties in conducting experiments. The ability to observe in detail and accurately is the foundation of the scientific method and contributes to the development of an objective attitude. However, the findings also reveal the limitations of the video approach in developing aspects of scientific attitudes related to independence, responsibility and resilience in the face of experimental failure. These attitudes are developed more through direct experience of overcoming challenges and problems that arise during the practicum. Nevertheless, the video demonstration approach remains effective in developing critical thinking skills, especially when equipped with reflective questions that encourage students to analyze cause-and-effect relationships in observed chemical phenomena.

The Effect of Student Worksheet-Based Approach on the Formation of Scientific Attitude

The results of the analysis show that the LKS-based approach in chemistry practicum has a significant contribution to the formation of several aspects of scientific attitudes that are different from the video approach. The most prominent aspects of scientific attitudes developed through the use of LKS are accuracy, honesty in recording data, perseverance, and responsibility [14]. The experience of conducting experiments directly with the guidance of the LKS requires students to be careful in following procedures and accurate in making measurements, which directly helps foster accuracy as part of a scientific attitude. In addition, the process of recording observations in the format provided by the LKS develops scientific honesty where students are faced with the choice to report data according to what they actually observe, not what they expect. The use of LKS also encourages the development of perseverance and responsibility, especially when students have to repeat complex procedures or face results that do not match expectations. These situations provide opportunities for students to learn to overcome frustration and persevere in finding solutions, which are important characteristics in the scientific process. Furthermore, the format of the worksheet that requires students to write conclusions based on data they collect themselves helps develop inferential thinking and the ability to make decisions based on empirical evidence. Although effective in these aspects, the conventional worksheet approach is often suboptimal in developing creativity and divergent thinking skills, especially if the worksheet is overly structured and only leads students to one correct answer or result.

Comparison of the Effectiveness of the Two Approaches in the Formation of Scientific Attitudes

A comparative analysis of the two practicum approaches revealed that each has advantages and limitations in the context of scientific attitude formation. The video-based approach is superior in developing detailed observation skills, mental visualization, and conceptual understanding of complex chemical phenomena [15]. This approach is also more effective in demonstrating the application of chemical concepts in real contexts that may be difficult to replicate in school laboratories, thus contributing to the relevance and contextualization of knowledge. On the other hand, the LKS-based approach shows advantages in the development of procedural skills, independence, and resilience in the face of experimental challenges. The hands-on experience facilitated by the LKS also contributed significantly to the formation of students' confidence in carrying out laboratory procedures independently. From a pedagogical perspective, the two approaches appear complementary in developing a comprehensive spectrum of scientific attitudes. The video approach offers the conceptual framework and visualization needed to understand chemical phenomena, while the LKS provides the opportunity to apply that understanding in a real experimental context. This finding indicates that the combination of the two approaches has the potential to create synergies that optimize the formation of students' scientific attitudes holistically. In the context of inquiry-based learning, the video demonstration can serve as an initial stimulus that arouses curiosity and provides a conceptual framework, while the worksheet facilitates the exploration and experimentation process that encourages the development of independence and scientific inquiry skills.

Factors Affecting the Successful Implementation of the Two Approaches

Analysis of various implementations of both practicum approaches identified several key factors that influence success in the formation of scientific attitudes. The first factor is instructional design that emphasizes the process of inquiry and critical thinking, rather than mere verification or confirmation of theory. Effective demonstration videos not only show procedures and results, but also ask reflective questions that encourage students to analyze and question the observed phenomena. Similarly, effective worksheets are designed with a level of openness appropriate to students' abilities, providing space for independent exploration and discovery, not just following rigidly prescribed steps. The second factor is the quality of integration between practicum activities and the overall learning structure. The successful implementation of both approaches depends heavily on how the practical activities, whether through videos or LKS, are integrated into a coherent learning flow with clear competency targets. Meaningful pre-lab and post-lab discussions, reflection activities, and opportunities to apply learned concepts in new contexts are important elements in maximizing the impact of the practicum approach on the formation of scientific attitudes. In addition, the role of the teacher as a facilitator is also crucial, especially in providing appropriate scaffolding, helping students connect observations with theoretical concepts, and creating an atmosphere that encourages inquiry and experimentation. Practical factors such as video duration, production quality, and clarity of instructions and layout of the worksheets also have a significant effect on the successful implementation of both approaches.

Integration of Video-based Demonstration Approach and LKS in Chemistry Practicum

The results of the analysis show an increasingly strong trend in the integration of video-based demonstration approaches and LKS as complementary strategies in high school chemistry practicum. The most common integration model involves the use of video demonstrations as a pre-lab stage that provides conceptual and procedural orientation before students conduct LKS-guided experimental activities. This integrative approach allows students to visualize procedures and phenomena before carrying them out directly, thus improving understanding and reducing procedural errors. Video demonstrations can also be used to point out critical or dangerous aspects of the experiment that require special attention, while the worksheet provides step-by-step guidance during the practical. Another integration model identified was the use of videos as a supplement or alternative for experiments that cannot be conducted directly due to time, facilities or safety constraints. In this model, students perform some experiments directly with the guidance of the worksheet, while other complex or dangerous experiments are observed through video demonstrations, followed by data analysis and discussion. This combination approach effectively bridges the gap between hands-on experience and conceptual visualization, providing a richer context for students to develop a comprehensive understanding of chemical processes. A well-designed integration strategy is also able to optimize learning time allocation and overcome various logistical limitations often encountered in chemistry learning, without compromising the goal of scientific attitude formation.

Pedagogical Implications and Recommendations for Learning Practices

The findings from this comparative analysis have several important implications for chemistry learning practices at the high school level. First, educators need to adopt a more balanced approach in integrating digital technology with hands-on experience in chemistry practicum. Instead of viewing video-based demonstration and LKS approaches as a dichotomy, they need to be seen as complementary components in a comprehensive learning ecosystem. The second implication relates to a more flexible and adaptive chemistry curriculum design, allowing a combination of various practicum approaches according to the characteristics of the material, the availability of resources, and student learning needs. Based on the analysis that has been done, several practical recommendations can be formulated for the development of effective chemistry practicum in fostering scientific attitudes. Educators are recommended to develop demonstration videos that not only focus on procedures, but also stimulate critical thinking through guiding questions and presentation of phenomena that challenge students' intuitive understanding. For the LKS, it is recommended to develop a more open and investigative format, providing space for students to formulate research questions, design experimental procedures, and develop data analysis methods independently with appropriate levels of scaffolding. The integration of reflective elements in both approaches, such as laboratory journals or post-lab discussions, is also recommended to help students identify their own scientific attitude development. At the system level, there is a need for continuous professional development for chemistry teachers to improve their ability to design and implement practicums that integrate digital technologies with hands-on experiences effectively.

CONCLUSION

Fundamental Finding : The results of the literature analysis show that the video-based demonstration approach and student worksheets (LKS) have their respective advantages in shaping the scientific attitudes of high school students in chemistry practicum. Video demonstrations excel in visualizing complex concepts, time efficiency, and developing curiosity and critical thinking. Meanwhile, the LKS approach is more effective in shaping scientific attitudes such as accuracy, honesty, and responsibility through direct experience. The combination of the two has the potential to provide a more comprehensive, in-depth and adaptive learning experience to various learning contexts. Therefore, integrative use of both is a promising strategy to optimize chemistry practicum learning in the digital era. **Implication :** This finding highlights the importance of adopting a blended instructional model in chemistry practicum. Chemistry teachers are advised to integrate video and LKS approaches in practicum implementation to accommodate the diversity of student learning styles and limited laboratory facilities. Videos should not only show experimental procedures, but also stimulate questions and reflective thinking. The worksheets need to be designed with a higher level of openness to encourage students to think critically and independently. In addition, professional training for teachers is important so that they are able to develop and implement technology-based practicum methods effectively and oriented towards the formation of scientific attitudes. **Limitation :** Although the literature supports the effectiveness of both video demonstrations and LKS in enhancing scientific attitudes, the analysis is limited to secondary sources and lacks empirical validation in varied classroom settings. The contextual factors such as school infrastructure, teacher readiness, and student digital literacy may influence the practical integration of both approaches, which were not fully addressed in this study. **Future Research :** Further research is recommended to empirically test the effectiveness of combining video demonstrations and LKS in diverse educational settings. Studies should also explore the long-term impact of this integration on students' scientific attitudes and conceptual understanding. Additionally, future investigations may focus on developing standardized frameworks for designing video content and worksheets that align with different curriculum goals and student competencies.

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