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Science Laboratory Readiness and Learning Resource Needs in Madrasah Ibtidaiyah: A Study in Pekalongan

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Abstract: Science learning is an important part of the Islamic elementary school (Madrasah Ibtidaiyah/MI) curriculum. The orientation of science learning in MI is to shape students' attitudes of loving knowledge, fostering curiosity, developing critical and scientific thinking skills, and using science in everyday life. To develop science learning requires learning media, adequate laboratories, and skilled teachers. This study uses a qualitative approach, utilizing observation, interview, and documentation techniques in collecting data. The focus of this study is analyzing science learning practices in MI in Pekalongan City and Regency. The results show that curricularly, science learning has become one of the main materials and received a sufficient time allocation, however, science learning practices have not run according to the curriculum orientation. First, there is still a lack of science learning facilities and laboratories, second, science learning does not provide sufficient practical experience for students, and third, not all teachers are skilled in using science practicum tools. To improve the quality of science learning, this study recommends providing adequate science learning facilities, developing practical learning, and improving teacher skills.

Keywords: *science learning, laboratory, madrasah ibtidaiyyah, learning resource neeeds*

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INTRODUCTION

Since 2022, the Indonesian government has implemented the Independent Curriculum for all levels, from elementary to higher education. This Independent Curriculum does not replace the 2013 Curriculum, but rather serves as an extension of the 2013 Curriculum, addressing the challenges of the 21st century, the Industrial Revolution 4.0, and as an evaluation of the implementation of the previous curriculum. Several developments within the Independent Curriculum include expanding school authority to develop innovative learning, focusing on essential materials, involving community participation in education, and developing educational programs tailored to the needs of students and their social environment.

Other policies and innovations in the basic education curriculum include strengthening science learning and allocating more learning time compared to the previous curriculum. In addition to the increased time allocation, there are also changes to the curriculum policy for science learning. In the independent curriculum, Natural Sciences is presented alongside Social Sciences, under the name IPAS (Social Sciences). This integration is intended as an integrative approach to strengthen students' knowledge of science and its application in everyday life. Science learning is provided to students starting in grade III, with material weight adjusted to the students' level of thinking maturity and their needs for its application in everyday life. The development of this science learning material aligns with the characteristics of the independent curriculum, namely project-based learning, oriented toward essential material, and tailored to students' needs (Ambarwati et al., 2024).

Science learning in elementary education is intended to introduce science, foster students' curiosity about science, develop critical thinking skills, utilize science in everyday life, and serve as a foundation for science learning at the next level (Pratiwi et al., 2025). The focus of science learning for elementary school and Islamic elementary school students is not yet on mastering complex concepts and knowledge, but rather on introducing science to everyday life. To develop ideal science learning in accordance with the curriculum, several appropriate instruments are needed, namely adequate learning resources, appropriate learning strategies and approaches, and competent teachers (Fitria, 2025).

To understand the implementation of science learning in elementary madrasas, a preliminary study was conducted in several elementary madrasas in Pekalongan city and regency. The observation revealed that science learning practices do not yet align with the current curriculum concept. Science learning has not been developed with a pleasant atmosphere (joyful learning), simulation and practicum activities are rarely carried out, and some students appear to show little interest and enthusiasm in learning. This study reveals

the factors that hinder science learning in elementary madrasas and formulates steps that need to be taken to improve the quality of science learning.

METHOD

The locus of this research is in Pekalongan City and Regency, with the object of study of science learning in Madrasah Ibtidaiyyah. The number of Madrasah Ibtidaiyyah in Pekalongan City is 44 and in Pekalongan Regency 129 educational units. Data was taken from the madrasahs that were sampled in the study, by considering representativeness and suitability to needs (purposive sampling). Data collection was carried out by observing science learning practices, observing the completeness of learning facilities, in-depth interviews with teachers and reviewing documents (curriculum, lesson plans) and other relevant documents. The instruments used were observation guides, checklists and interview guides. To obtain valid data, triangulation of data sources and triangulation of techniques were carried out and at the final stage, sorting was carried out. Informants in this study were teachers who teach science, students and education experts.

This research was conducted using a qualitative approach with an integrative interaction pattern, with analysis procedures starting from data collection, data reduction, data presentation and drawing conclusions.

Table 1. Research instruments

Element	Analysis aspects	Instrument
Learning tools	Completeness of science learning facilities	Observation guide
Laboratory	Laboratory availability	Observation & Documentation Guide
Teacher competency	Teacher skills in using media	Observation & interview guide
Learning strategies	Learning strategies and models	Observation & interview guide

RESULTS AND DISCUSSION

Results

The results of this study consist of three things, firstly the content of science learning materials in MI, the need and availability of practical facilities in science learning and science learning practices in MI.

First: content of science learning at MI

Science learning in Islamic elementary schools is provided from grade III to grade VI in one subject, Natural and Social Sciences (IPAS). The allocation of time for learning IPAS for grades III to V is 130 hours of curricular lessons and 60 hours of co-curricular lessons. For grade VI students, the allocation of time for learning IPAS is 160 hours of curricular

lessons and 80 hours of co-curricular lessons. In this study, the focus of the study is the practice of learning science (IPA). The government has determined the essential materials for learning science for elementary schools and Islamic elementary schools or phases B and C. Schools and madrasas can develop learning materials according to the conditions of the educational environment and the needs of students (Sutinah et al., 2025).

The science learning material in natural science lessons at elementary madrasas is displayed as follows;

Table 2. Science learning materials in MI

Class	Material	Sub-material
III	Animals and the environment	Herbivores, carnivores and omnivores, animal bodies and their functions, cycles, metamorphosis, ecosystems, energy and forms of energy
IV	Plants and energy	Roots, stems, leaves, fruit, photosynthesis process. Plant reproduction, mass and volume, substances and their changes, force, magnetism, gravity, forms of energy, energy sources.
V	Light	Light, properties of light, sound, properties of sound, how the ear works, ecosystem, magnets, electricity, climate, pollution, global warming
VI	Anatomy & Solar System	Skeleton, joints, muscles, nervous system, diseases of the motor and nervous system, solar system, revolution and evolution of the earth

Source: *MI Natural Sciences textbook*

The orientation of science learning in Madrasah Ibtidaiyyah is to introduce science to students from an early age, foster curiosity about science, utilize science in everyday life, and provide provisions for further education. The level of complexity of science subjects is structured by considering students' cognitive maturity and social life. Science learning outcomes in elementary schools / MI are formulated using the SOLO taxonomy (structure of the observed Learning Outcome), which emphasizes the development of students' abilities to understand science material through the process of observing, analyzing, and connecting natural and social phenomena in an integrated manner. This SOLO taxonomy enables students to have theoretical knowledge about science, linking it to their environment and social life. After linking knowledge to their social environment, students are able to solve problems they face.

Table 3. SOLO taxonomy in science learning

Material	Cognition	Activity
Ecosystem	Environment, life cycle, biotic	Observing the rice field environment, caring for plants, feeding animals
Anatomy	Joint system	Demonstrate joint movements, do sports, stretch, eat healthy and nutritious food

For example, in learning about the environment, students are encouraged to develop knowledge through experience. Students are encouraged to learn about the environment not visually, but through activities in nature. By observing the natural environment, students engage in observation, identification, analysis, and reflection. This process of developing knowledge through meaningful reflection provides students with experiences that engage both their emotions and psychomotor skills. This type of science learning process is modeled in the current curriculum. The learning paradigm is shifting from memorizing knowledge to constructing knowledge. The current curriculum demonstrates a shift in the learning paradigm, from a memorization approach to constructing knowledge (Safitri et al., 2026).

Second; science learning tools

Science learning requires supportive and adequate learning resources and media. These learning resources pedagogically assist teachers in delivering material and helping students understand it. Based on the learning materials in the independent curriculum, as shown in Table 1, science learning in Islamic elementary schools requires the following learning resources and media:

Table 4. The need for science teaching aids and learning materials

Material	Category	Type
Mechanics, force and energy	Simple machine	Pulley, inclined plane, axle, lever
	Balance Sheet	3-arm balance, scales
	Spring and Free	spring tool
Heat and calories	Temperature and change meter	Thermometer, Musschenbroek, spirit lamp
Light and optics	Mirror	Flat mirror, convex mirror, concave mirror, magnifying glass, optical cable
Electricity and magnetism	Magnet	Bar magnet, cable, switch, light bulb, dynamo, battery
Glassware & basic laboratory	Measuring instrument	Test tube rack, test tube, measuring cylinder, pipette, beaker
Anatomy & Biology	Visual Display	Torso, eye model, ear, heart, lung, stomach, microscope, magnifying glass, plastic aquarium, plant structure

Source: *MI Science and Technology Textbook*

Science learning requires media, materials, and tools. Science learning media are used to assist teachers in delivering material, with the goal of helping students understand concepts and the material. Science learning materials and tools are used to provide students with experiences in conducting experiments and shape their learning experiences. With science learning materials and tools, students can learn factually.

In this study, it was found that Madrasah Ibtidaiyyah in Pekalongan City and Regency do not yet have adequate media, materials and tools for science learning. First; most Madrasah Ibtidaiyyah only have learning media in visual form, such as pictures of types of animals, pictures of plants and their parts, pictures of animal anatomy, pictures of human anatomy. Second; a small number of Madrasah Ibtidaiyyah have three dimensional science learning media and tools, such as miniatures, torsos, geometric shapes, kinetic energy demonstration tools, test tubes and mixing. Third; Madrasah Ibtidaiyyah in Pekalongan City and Regency do not yet have a special room or laboratory used for science learning. Science learning media in the form of pictures are generally attached to the classroom walls, while miniature, three-dimensional or simulator learning media are stored in the teacher's office.

In this study, the following conditions were found: some media and teaching aids were still neatly wrapped from the factory, some media were stored in open cupboards so they were dusty and some media appeared to be rarely used (observations August – September 2026).

Third; science learning practices in Madrasah Ibtidaiyyah

Science instruction at the Madrasah Ibtidaiyyah (Islamic elementary school) utilizes materials aligned with the current independent curriculum. Curricularly, the Madrasah Ibtidaiyyah has the authority to develop learning materials tailored to the needs and characteristics of its students. Therefore, the curriculum content taught at the Madrasah Ibtidaiyyah is a result of innovations in the national curriculum and additions to the madrasah curriculum, or the School-Based Curriculum (KTSP).

Science instruction at Islamic Elementary Schools (Madrasah Ibtidaiyyah) is conducted in the classroom by each class teacher. Science instruction at Islamic Elementary Schools (Madrasah Ibtidaiyyah) has generally been conducted using the lecture method. The teacher explains the material, and students listen attentively to the teacher's explanation while paying attention to learning resources. For some materials, such as introducing animal anatomy, the teacher explains by showing animal body parts in pictures. When explaining human anatomy and the five senses, the teacher explains the material by showing pictures and demonstrating by holding body parts. It is still very rare for teachers to teach human anatomy material by holding a torso demonstration. Students are still rarely given the opportunity to learn about human body parts using a torso demonstration.

For light and energy, most learning is conducted through lectures accompanied by visual aids. Simulations or practical exercises are rarely used. Several teachers stated that their madrasahs lacked energy laboratory equipment. For the introduction to magnetism topic, learning has largely been conducted through practical exercises. All madrasahs have learning media for magnetism, and because the media is physically accessible to the

classroom, the introduction to magnetism has been implemented using practical and simulation methods.

In metamorphosis, learning is conducted through lectures accompanied by visual aids. Teachers have not yet implemented observational learning, either in the natural environment or in the laboratory. In science lessons, the use of large-screen visuals (LCDs) to help students recognize objects through simulations has not been widely implemented, even though all Islamic elementary schools have projectors. Some science learning materials are delivered through lectures without media, some are delivered with the aid of media, and some materials that require laboratory and practical experience have never been implemented.

Table 5. Science learning practices in MI

Material	Method	Media	Intensity
Animals and the environment	Lecture	Picture	Often
Plant	Lecture	Picture	Often
Energy	Lecture	Picture	Often
Light	Practice	Flashlight	Often
Body anatomy	Lecture & observation	Torso	Seldom
	Practice & simulation		
		magnet	Often
Magnet			
Energy and force	Practice and simulation	Practical kit & simulator	Seldom

Source: *Observation of Science Learning at MI*

Discussion

This study discusses two theoretical perspectives: the first is instructional media theory, and the second is instructional strategy theory. The latter analyzes the need for media in science learning, and the latter analyzes the appropriateness of using strategies and approaches in science learning.

First: the need for media and laboratories in science learning

In learning theory, one of the important elements that influence the learning process and outcomes is media, tools, and materials. For teachers, learning media serves to facilitate teachers in delivering learning materials and for students, it will make it easier to receive and understand concepts or learning materials. Learning media also serves to increase focus, interest, and enthusiasm of students. Learning media also serves to build a shared perception and avoid verbalization. Good learning media is the result of teacher creation by paying attention to (1) student characteristics, (2) in accordance with learning objectives, (3) in

accordance with the material being taught, and (4) in accordance with the conditions of the educational environment (Miftah, 2022).

To increase student focus and interest in learning, media needs to be designed in an engaging manner, both in terms of material, form, and appearance. Several studies have shown that good media design increases student interest, enthusiasm, and understanding of learning materials (Sugiarti et al., 2025). Learning media are basically grouped into four, namely visual, audio, audiovisual, and motion learning media. In its development along with technological advances, currently many media are based on information and communication technology (Al Kutsi, 2025). Visual learning media aims to improve students' understanding through the function of sight, audio to improve students' understanding through the function of hearing, audiovisual and audiovisual to improve students' understanding through the function of sight and hearing. Motion learning media functions more comprehensively, namely helping students understand the material by paying attention and practicing a function directly. In learning, media is always needed, according to the type and nature of the material being studied (Pinasti & Pratiwi Kartika Sari, 2025).

Science learning materials in elementary madrasas cover the introduction of body parts and their functions, human anatomy, energy, movement systems, light, habitats, ecosystems, and the solar system. Therefore, the learning tools and media needed must be appropriate to the material being taught. The orientation of science learning in madrasas is to foster students' curiosity, love of science, and ability to utilize it in everyday life. Therefore, media, tools, and materials are needed to help students understand the learning material with pleasure and ease. This enjoyment aspect is crucial for students, so they can learn comfortably and avoid boredom. The ease aspect is also important, so students perceive science as easy and not difficult. Interesting media for elementary madrasa students include information technology-based animated videos, interactive games, augmented reality, simulators, and 3D teaching aids (Widyaningrum et al., 2022; Hasanah & Sudira, 2021; Febrina & Setiawan, 2024)

In observations at elementary madrasah in Pekalongan City and Regency, it was found that madrasas do not have sufficient science learning facilities. This is evident in two things. First, not all elementary madrasas have the science learning media as needed, according to the material being studied. A small number of madrasas have sufficient learning media, but the majority do not have them. In general, the learning media that elementary madrasas already have are in the form of pictures, such as pictures of metamorphosis, pictures of human anatomy, pictures of light. Demonstrations and learning media that are more helpful in learning, such as energy lab equipment, color and reaction mixing glasses, lab equipment for energy and force, light, and the solar system, are not yet available.

The second indicator is the availability of science learning spaces or laboratories. All elementary madrasas do not yet have dedicated science learning spaces equipped with learning media, practical tools and materials, and other learning support needs. Due to limited learning media, practical tools, and laboratories, science learning is more often conducted through visuals or teacher-described narratives. The government authority for elementary madrasa education in Pekalongan City stated that currently, no elementary madrasas in Pekalongan City and Regency have science learning laboratories. Science learning is conducted in the classroom, and if learning media is needed, teachers take them from the science learning media cabinet.

The laboratory's function in learning includes serving as a learning resource center and a space for conducting scientific experiments. Theories learned are used to conduct experiments in the laboratory (Suryana et al., 2024). The more frequently students conduct scientific experiments, the more comprehensive their knowledge will be. Conversely, if learning is never accompanied by scientific research or experiments, theories or knowledge will not be fully understood.

Second: the need for appropriate learning strategies

Learning strategies and approaches are crucial components of teaching and learning. Appropriate learning strategies and approaches significantly contribute to the learning process and learning outcomes (Sulthon, 2024). Appropriate learning strategies also make students feel more comfortable in learning and less likely to get bored. Conversely, inappropriate learning strategies can have negative impacts on students, including reduced enthusiasm, a lack of comfort in learning, and even lower learning outcomes. Several studies have shown a correlation between the use of learning strategies and student learning outcomes (Maryanti & Sartono, 2024; Han & Ellis, 2023; Marantika, 2021)

The selection of learning strategies takes into account many factors, including the nature of the learning material, time, and student characteristics. Cognitive learning materials can be taught through discussions, brainstorming, or active debate, among others. Affective materials, such as mental development, caring attitudes, empathy, and so on, are more appropriately taught using social experience strategies, portfolios, and psychological and intuitive approaches. Psychomotor learning materials are more appropriately taught through practical activities, demonstrations, performance tests, and so on. Elementary school students and Islamic elementary schools require strategies and approaches appropriate to their mental age. The appropriate strategy for learning science for elementary school and Islamic elementary school children is the science process skills strategy. This science process strategy is not only about mastering scientific theory, but also about

understanding the process of science formation and using science to solve everyday life problems (Media, 2026).

Science learning materials in elementary madrasas consist of cognitive, affective, and psychomotor domains. For example, metamorphosis covers the life cycle of animals. To learn metamorphosis, students can be encouraged to make observations. However, due to time constraints and the limited natural environment around the madrasa, observations can be conducted by watching films about metamorphosis. Currently, learning media sources about metamorphosis can be accessed or even downloaded from the internet. Advances in the digital era can be utilized to develop information technology-based science learning, provided teachers have digital skills (Miftah, 2022). Learning using this observation strategy can be conducted in the classroom using a projector screen. Currently, all elementary madrasas have projector screens. This condition is consistent with Imanuela & Setiawan (2025) findings, which state that the use of an LCD projector enhances students' participation, focus, and learning motivation during the instructional process.

In human anatomy, learning is facilitated by using a three-dimensional observation strategy, namely the human torso. Students are visually explained about human anatomy, followed by holding human body parts and moving their functions in the form of a torso. Learning using this torso and practical strategy is more engaging for students, facilitates comprehension, and stimulates critical thinking, compared to learning using a lecture strategy, which uses visual media in the form of images of the human body.

Learning about sound, energy, and light can be done using an experimental strategy so that students have experience-based knowledge. To carry out this constructivist learning, two things are needed: first, appropriate media, namely a sound, energy, and light lab kit, and learning carried out using observation and experimentation strategies. However, due to limited learning media, learning about sound, energy, and light is often done using lectures and visualization strategies. As a result, students do not have practical experience and a better learning experience. Students mostly understand the properties of light, energy, and sound propagation not from the results of experiments, but from recording teacher explanations.

The existence of science laboratories in learning is crucial. First, they provide students with the opportunity to learn science in a dedicated space and with adequate learning media. Second, psychologically, students' practical experiences in laboratories have a strong emotional impact, making them feel like science can be learned, even easier and less difficult. This feeling will facilitate the development of a perception of science as part of everyday life for students. Laboratories play a role in testing abstract concepts in real-world contexts and

situations (Kampfmann et al., 2023). Moreover, science laboratory practices can support students' scientific literacy (Eymur & Çetin, 2024).

To improve teacher skills, the government provides training on the 2013 curriculum, the independent curriculum, project-based learning, and the love-based curriculum. However, until 2025, the government has not provided any training to improve teacher competency in science teaching. Ten respondents in this study who teach at Islamic elementary schools also admitted to having never participated in science learning training, either as government delegates or individually. Some training often offered by training institutions or teacher professional organizations focuses on educational management, curriculum, and an introduction to digital education systems. This situation has resulted in teachers' pedagogical and professional competencies in teaching science being underdeveloped.

Science learning for elementary school students will improve if three main components are met: first, sufficient media and science learning aids are available, rooms or laboratories are available for practical learning, and teachers are skilled at teaching science using appropriate methods and approaches (Sapitri et al., 2025). Teachers can develop media creatively, utilize digital technology to produce engaging media, and develop strategies and project learning or other approaches that foster curiosity and critical thinking in students (Wahyuni et al., 2025; Gurning et al., 2024; Handoko et al., 2025).

A competent teacher in teaching science is not one who can explain scientific products, but one who can engage students in the scientific process. Science learning will become more engaging if projects or practical activities are frequently included, to connect children's knowledge with facts. With a dynamic approach, students find learning science easier and more enjoyable (Adawiyah et al., 2025). If these three elements are met, students will enjoy learning science, view science as easy and enjoyable, and will foster enthusiasm for learning science at the next level of education, in line with the objectives of the current science education curriculum.

CONCLUSIONS

This research concludes that science learning in Madrasah Ibtidaiyyah (MI) is given starting from grade III with an allocation of 180 hours of intracurricular and 36 hours of co-curricular and in grade VI 160 hours of intracurricular and 32 hours of co-curricular. The science content in the MI curriculum contains basic concepts of science and biology. In the science cluster, the objects of study are energy, energy sources, physical phenomena and their changes and the solar system. In the biology cluster, the objects of study are the environment and its habitat, flora, fauna, anatomy and human growth and development. The orientation

of science studies in the MI curriculum introduces basic concepts of science, fosters children's love of science and introduces science in everyday life.

Currently, Islamic elementary schools lack adequate science learning facilities and media, and no Islamic elementary schools have science laboratories. As a result of these limitations, science learning is primarily based on knowledge transfer, while process approaches, practical work, and the development of knowledge through experiential learning are lacking. Students do not yet fully appear to enjoy, be enthusiastic about, or understand science easily.

To improve science learning, three main things are needed. First, adequate science learning media, including audio, visual, audiovisual, and motion-guided demonstrations (simulators). Second, laboratories equipped with practical equipment aligned with basic science learning competencies are needed. Third, teachers who possess the skills to teach science and operate the demonstration equipment and practical tools in the laboratory. This research recommends that the government at all levels allocate budget for the procurement of laboratories and science learning facilities and provide programs to improve science teaching skills for elementary madrasa teachers.

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