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Cultivation of Digital Literacy Based Communication in Natural Science Learning at Al-Abidin Primary School of Information and Communication Technologies

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Abstract: The aim of this research is to describe the cultivation of written-based aspects of communication digital literacy in learning Natural Sciences (Science) and exploring oral-based communication aspects digital literacy in learning Natural Sciences (IPA). The research method uses a qualitative research approach, the research design uses a case study. Data collection techniques in research are observation, interviews and document analysis. The results of the research show that communication culture is based on digital literacy and succeeded in creating a dynamic and innovative Natural Sciences (Science) learning environment. Students demonstrate significant improvement in the ability to use technology to express scientific ideas, both written and verbal. The use of digital tools such as Canva, PowerPoint and online collaboration platforms not only increases student engagement, but also facilitates a deeper understanding of Natural Sciences (Science) concepts. This culture successfully integrates aspects of written and oral communication, enabling students to develop the skills needed in the 21st century.

Keywords: Cultivation of Communication, *Digital literacy*, Natural Science Learning

Introduction

Education is the key to improving the character and quality of human resources. In the era of digitalization, the use of technology in the learning process needs to be done effectively. Elementary school is an important period for children's growth and development because it is easy to absorb information and values (Sunanda et al. 2020). Basic education determines a student's future through imparting fundamental knowledge, skills and values. The challenges of the 21st century require the development of skills such as critical thinking, creativity, collaboration, communication, and problem solving. The 21st Century Student Competency Profile states that these skills must be improved through appropriate learning strategies (Triadi et al. 2022). Therefore, education must prepare students with these skills to be able to compete and successfully meet the demands of the 21st century. Primary school is very important in helping children realize their potential and prepare themselves for life in the digital era.

Communication is an important 21st century skill for elementary school students because it influences their overall academic development and effectiveness. Efficient communication skills enable students to express themselves clearly, understand others, collaborate with peers, and have meaningful learning experiences. Research by Chasanah et al. (2020); Lan &

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Hoa (2023); Rizqi & Hawa (2023) shows that developing communication skills through various strategies, such as games and ethnomathematics-based contextual learning, can significantly improve students' abilities. Additionally, building strong communication skills early can help students academically, socially, and professionally throughout their lives as these skills are critical to success in the modern world, including building relationships, problem solving, and critical thinking.

Cultivating communication in modern education is important because students can express their thoughts, ideas and opinions clearly and effectively. Communication is a key skill that students must acquire in the 21st century, as complex communication skills are essential given the demands of today's global power relations. In addition, incorporating communication skills into 21st century learning also includes aspects of children's motor development, highlighting the importance of communication in the learning process (Nurazka, Fitriasari, and Widjayatri 2022). Communication is an integral part of human activity. In the learning process, communication involves conveying ideas and concepts orally or in writing as well as forming understanding (D. R. Putri et al., 2022). Cultivating communication in learning helps students improve their reading, writing and speaking skills. In understanding subject matter, students need to be able to read and understand writing, write clearly and descriptively, and convey ideas orally. Communication skills include conveying meaning through verbal and nonverbal behavior. Students' communication skills consist of two types of codes: (1) verbal codes consisting of language; and (2) nonverbal code, which consists of signs or silent language. There are several effective communication techniques that can help people communicate smoothly and achieve their goals. These steps include looking the other person in the eye, having a clear voice, pleasant facial expressions, correct grammar, and language that is short, clear and easy to understand (Larasati, 2021).

In Australia, primary school students are expected to develop a variety of 21st century skills, including communication. Companies in Australia emphasize the importance of communication skills for students to meet job requirements so that students are required to have skills such as written and oral communication skills (Sonnenschein & Ferguson, 2020). In addition, research Tajuddin et al. (2022) shows that in Malaysia students must have strong communication skills and digital skills. Primary school students in Malaysia are equipped with communication skills that will enable them to succeed in developing 21st century skills. The independent curriculum in Indonesia provides flexibility for teachers to improve students' abilities in the 21st century, by emphasizing the importance of communication skills (Setiawan et al., 2023).

Digital literacy has become a means used to cultivate communication. Digital literacy is the ability to use digital technology and communication tools to discover, evaluate, use, share and create content. Covers skills such as navigating the internet effectively, critically evaluating online information, understanding digital security and privacy issues, and using digital tools for communication and productivity. Mastering digital tools allows a person to communicate effectively across a wide range *platform online*, increasing collaboration and connectivity for students in schools (Widiyono & Millati, 2021). Educational technology plays an important role in encouraging freedom to learn in the digital era 4.0. To create engaging and dynamic classes, teachers and students can utilize a variety of technological tools, such as online platforms, interactive multimedia resources, and customized learning applications. Febriansyah et al. (2023) shows that learning media such as Visme have been proven to improve student learning outcomes. Using Visme as a learning aid with the right approach can have a positive impact on student learning outcomes.

Digital competence in elementary school classrooms includes a range of skills that are important for teachers and students to be able to navigate the digital world. These competencies include digital skills, digital culture, digital ethics and digital security. Mastering digital skills helps in daily work, digital culture helps preserve culture and protect creation, digital ethics helps avoid conflict, and digital security raises awareness of digital crimes (Isrokatun et al., 2022). *Digital literacy* It is critical for students and teachers to ensure that they can use digital devices, understand digital culture, and adhere to ethical and safety guidelines. Teachers' perceptions of learning strategies based on games also highlight the importance of using these methods to develop *digital literacy* in elementary school students (Sarah & Kemboi, 2023). In natural science (science) learning in elementary schools, digital literacy helps students acquire new skills that are relevant to the demands of the 21st century. Digital literacy includes the ability to use and utilize digital media, such as the internet and networks, as well as the ability to apply these skills in everyday life (Muhaimin & Dasari, 2022; Putri et al., 2022) using bibliographic analysis found that *digital literacy* is a topic that is often discussed in the context of learning in elementary schools, and the development of creative and innovative digital materials is important for students to help prepare new things for 21st century skills including

learning Natural Science (science) in elementary schools (Naila et al., 2021).

Based on survey results *Programme for International Student Assessment* conducted by the OECD shows a quite large gap between the literacy abilities of Indonesian students and the average of OECD countries, both in the aspects of reading and science. Only 25% of Indonesian students achieved a minimum level of reading literacy and 34% achieved a minimum level of science literacy, far below the OECD average of 74% for reading and 76% for science. In fact, almost no Indonesian students attain the highest literacy level (Level 5 or 6) compared to an average of 7% of students in OECD countries (PISA, 2023). These findings underscore the urgency to improve the quality of education in Indonesia, including by cultivating communication-based education and digital *literacy* in learning, especially Science Knowledge Nature (science) in elementary school. This acculturation is expected to increase students' scientific literacy skills while preparing them to face challenges in the digital era, thus bridging the gap with global standards.

Initial observations at SD ICT Al-Abidin Surakarta show efforts to integrate written and oral communication *digital literacy* in learning Natural Science (IPA). Even though students routinely make digital reports and presentations, and participate in online discussions, they still encounter technical and adaptation obstacles, especially for early grade students. Utilizing *digital literacy* has great potential to improve students' communication culture. Barriers to cultivating communication in learning Natural Science (IPA) not only occur in digital marketing strategies in schools, but also in the context of the use of information media and technology. According to research Kisminanti et al. (2022) teacher Natural Science (IPA) faces obstacles in integrating various types of technological devices and computers for learning information purposes and in developing digital products as learning resources. Research on cultivating digital literacy-based communication in Natural Sciences (IPA) learning in elementary schools is very important because it provides an understanding of how students can acquire skills. *digital literacy* and communication skills in learning Natural Sciences (IPA). Cultivating communication based *digital literacy* It can also help students understand Natural Sciences (IPA) in a more interactive and interesting way.

Based on the background that has been described, this research aims to describe the cultivation of written aspects of communication on learning Natural Science (IPA) based *digital literacy* in elementary school and explore oral aspects of communication on learning Natural Science (IPA) based *digital literacy* in elementary school.

Method

Research Design

This research uses a qualitative research approach, a qualitative approach was chosen to obtain an in-depth understanding of culture-based communication *digital literacy* in learning Natural Science (science) in elementary school. The research design uses a case study. This research chooses a case study approach because it focuses on culture-based communication *digital literacy* in learning Natural Science (science) in elementary school.

Data source

This research involved Natural Sciences (IPA) students and teachers as primary research data sources, then Natural Sciences (IPA) program coordinators as secondary data sources.

Instrument

Data collection is a systematic and standard procedure that is useful for obtaining the required data. In general, data collection in this research is the observation method, interview method, and documentation method.

Observation techniques are used by researchers who are actively involved in the learning process Natural Science (science) in elementary school. The researcher was present directly in the class to observe directly how *digital literacy* integrated in learning Natural Science (IPA). During observations, researchers paid attention to interactions between teachers and students, the use of digital technology, and communication strategies used in learning. These observations provide a comprehensive picture of implementation of digital *literacy* in the context of everyday learning.

Researchers conducted a series of in-depth interviews with various parties involved, including teachers, students and other related parties. Interviews with teachers focused on an in-depth understanding of teaching strategies *digital literacy* in learning Natural Science (IPA). In addition, interviews with students regarding their learning experiences with *digital literacy* in the learning context Natural Science (IPA). Interviews with other related parties such as program coordinators Natural Science (Science) at school or specialist *digital literacy* regarding practices and challenges in culture-based communication *digital literacy*.

The documents analyzed include teaching modules and other supporting documents related to learning Natural Science (science) in elementary school. Analysis

of this document provides additional understanding of how *digital literacy* integrated into the curriculum and learning practices in elementary schools.

Data analysis

The data analysis technique used in this research follows the flow proposed by Miles and Huberman, which includes data reduction, data presentation and drawing conclusions.

The data reduction process involves several steps, including removing irrelevant data, grouping data into larger categories or themes, and coding data to facilitate further analysis. Researchers systematically sift through data to identify emerging patterns, as well as to gain a deeper understanding of the phenomenon under study.

After the data has been reduced, the next stage is data presentation. The researcher organizes the reduced data into a form that is easier to understand, such as a narrative, chart, or diagram. The aim of presenting this data is to convey information clearly and systematically to readers or interested parties.

The final stage is drawing conclusions. At this stage, the researcher interprets the findings that emerge from the analysis of the data that has been reduced and presented. Researchers draw conclusions from the results of the analysis, identify significant patterns or trends and make generalizations that are relevant to the research context. In addition, researchers verify the conclusions to ensure their validity**.**

Result and Discussion

Results

Cultivating Written Aspects of Communication Digital literacy

SD ICT Al-Abidin is at the pinnacle of basic technology education with a unique comprehensive curriculum to prepare students for success in an ever-evolving technological world. The following is a table of written-based aspects of communication cultivation *digital literacy* Natural Science (IPA) SD ICT Al-Abidin Surakarta.

Table 1. Cultivating Written Aspects of Communication *Digital literacy* Natural Sciences (IPA) SD ICT Al-Abidin Surakarta

Aspect	Sub-aspects	Implementation
Use of digital applications	Making posters	Using Canva
	Presentation	Use of PowerPoint
	Practical report	Creation of digital reports
Digital based assignments	Crossword puzzles	Doing digital crosswords
	Poster design	Making digital designs or posters
Challenge	Writing rules	Weaknesses in applying writing rules to digital assignments

Cultivating written-based communication aspects *digital literacy* at SD ICT Al-Abidin Surakarta shows effective integration between technology and learning Natural Science (IPA). Students actively use applications such as Canva and PowerPoint to create digital posters and presentations, as well as create digital reports after practicum. This allows them to express their ideas visually and creatively. Digital-based tasks, such as crossword puzzles and poster making, also help develop skills of digital *literacy* students while remaining focused on the content Natural Science (VIOLENCE).

However, there are challenges in implementing this, especially related to weaknesses in writing rules for digital assignments. This shows the need for special attention to grammatical and structural aspects of writing in digital contexts. Overall, this approach is effective in developing students' written communication skills in a digital learning environment, although there is still room for improvement in the technical aspects of writing. By continuing to perfect this aspect, schools can further optimize the benefits of technology integration in cultivating written-based communication *digital literacy*.

Cultivating Communication Based on Oral Aspects Digital Literacy

Integrate *digital literacy* in learning has many benefits, namely students can learn how to use digital technology in the learning process, improve online communication skills, learn how to check the authenticity of online information, and much more. The following is the cultivation of oral-based communication aspects *digital literacy* presented in table 2.

Table 2. Cultivating Oral Aspects of Communication Based on Digital Literacy in Natural Sciences (IPA) at SD ICT Al-Abidin Surakarta

Aspect	Implementation
Digital presentation	Students create and present presentations using PowerPoint or Canva
Discussion and questions and answers	Students actively participate in class discussions Use methods such as raising your hand or speaking directly to communicate with the teacher
Student-centered learning	The teacher provokes discussion to encourage active student participation

Cultivating oral-based communication aspects *digital literacy* at SD ICT Al-Abidin Surakarta demonstrated effective integration between traditional communication skills and digital technology. Students actively create digital content, using applications such as PowerPoint and Canva for presentations, developing visual and verbal communication skills. Active participation in classroom discussions shows that digital technology enriches direct interactions, with students using diverse communication methods such as raising their hands or talking directly to the teacher.

Approach *student-centered learning* implemented through stimulating discussion, shifting the teacher's role to become a learning facilitator. Teachers encourage students to learn more and be better at critical thinking and communicating. This implementation demonstrates the school's commitment to combining oral communication skills with digital literacy, preparing students to face the communication demands of the 21st century and developing the skills necessary for future academic and professional success.

Technology Integration in Learning Natural Science (VIOLENCE)

Cultivation of oral and written communication based *digital literacy* for students serves to prepare students to face the rapid development of the digital era. Technology integration in learning Natural Science (IPA) can be seen in Table 3.

Table 3. Technology Integration in Natural Sciences (IPA) Learning

Aspect	Implementation
Use of digital devices	Computers, cellphones and projectors are used in learning
Digital learning resources	Use of the internet to search for information Learning videos and simulations

Technology integration in learning Natural Science (IPA) at SD ICT Al-Abidin Surakarta shows a comprehensive and innovative approach. The use of digital devices such as computers, cellphones and projectors reflect the school's commitment to adopting modern technology to improve the quality of learning. This device functions as an interactive medium that actively involves students. Digital learning resources, including the use of the internet, open up opportunities for students to explore concepts Natural Science (IPA) broadly, enriching learning resources and developing information literacy skills.

Students can expand their understanding of natural phenomena and abstract scientific principles through visualization of complex concepts in depth Natural Science (IPA) through the use of digital simulations and learning videos. By using this technology, it is not just learning Natural Science (Science) for the better, but also preparing students to face the challenges of the digital era. This approach encourages the development of critical thinking, creativity, and problem-solving skills, important skills in learning Natural Science (IPA) and everyday life in the 21st century.

Teaching and Evaluation Strategies

In an era of education that is increasingly integrated with digital technology, teaching and evaluation strategies play a vital role in ensuring the effectiveness of the learning process. Table 4 below presents a comprehensive overview of the strategies implemented, reflecting the school's commitment to cultivating communication-based communication *digital literacy.*

Table 4. Teaching and Evaluation Strategies at SD ICT Al-Abidin Surakarta

Aspect	Implementation
Language adjustments	The teacher adapts the language to the student's level of understanding
Communication evaluation	Oral: presentation, discussion, question and answer Written: assignments with digital applications

The teaching strategy at SD ICT Al-Abidin Surakarta shows high adaptability in the digital learning context. Teachers actively adapt the language used to students' level of understanding, ensuring effective communication in a technology-integrated learning environment. This approach facilitates knowledge transfer but also helps students understand and use digital terminology better.

The communication evaluation implemented reflects a comprehensive approach in assessing students' digital-based communication skills. Oral assessments through presentations, discussions and question and answer sessions provide opportunities for students to demonstrate their ability to communicate verbally with the support of technology. Meanwhile, written evaluations involving assignments with digital applications allow assessment of students' ability to express their ideas and understanding in writing in digital format. This combination of evaluation methods is not only effective in measuring the development of students' communication skills but also prepares them for various forms of communication in the digital era.

Challenges and Obstacles

In the process of implementing based learning *digital literacy* At SD ICT Al-Abidin Surakarta, several challenges and obstacles have been identified. Table 5 presents a summary of important findings in this regard, providing a clear picture of the areas that require special attention in efforts to develop more effective digital learning.

Table 5. Challenges and Obstacles at SD ICT Al-Abidin Surakarta

Aspect	Challenges and Obstacles	Implications
Limited Facilities	Obstacles in exploration outside the classroom	There is a need to develop infrastructure to support broader digital-based learning
Technical Obstacles	Problems with device not turning on or internet connection	Indicates the need for adequate technical support
Student Initial Skills	Difficulty operating a computer in early grades (1-2 elementary school)	Shows the need for gradual introduction of digital technology from an early age

The research results revealed three main challenges in implementing learning-based learning *digital literacy* at Al-Abidin ICT Elementary School, Surakarta. First, limited facilities, especially for exploration outside the classroom, because the school is currently undergoing repairs, shows the need for more comprehensive infrastructure development. This is important for expanding the scope and effectiveness of digital-based learning, enabling students to apply their digital skills in broader and more diverse contexts. Second, technical problems such as a malfunctioning device or internet connection problems indicate a need for more robust and responsive technical support.

The third challenge is related to students' initial skills, especially difficulties in operating computers in the early grades (1-2 elementary school). These findings emphasize the importance of the gradual introduction of digital technology from an early age, taking into account the level of students' cognitive and motor development. Implementing learning strategies that are tailored to students' abilities at each grade level will be very helpful in building a strong foundation for *digital literacy*. By overcoming these challenges, SD ICT Al-Abidin Surakarta can increase the effectiveness of learning-based learning *digital literacy*, better preparing students to face the demands of the digital era.

Discussion

SD ICT Al-Abidin Surakarta implements an innovative curriculum that integrates information and communication technology into core learning. The school's vision focuses on academic excellence, mastery of technology, the formation of Islamic morals, and the development of global insight. The school's mission includes strengthening Islamic character, increasing digital competence, and preparing students to become competent global citizens. The educational objectives at SD ICT Al-Abidin include implementing thematic learning based on a scientific approach, developing student creativity and innovation, mastering the basics of technology, as well as internalizing and implementing religious values in everyday life. Through a project-based learning approach and hands-on experience, this school seeks to equip students with the practical skills, critical thinking abilities and problem solving needed to face the challenges of the digital era.

Cultivating communication based *digital literacy* on Natural Sciences (IPA) learning at SD ICT Al-Abidin Surakarta shows effective integration between technology and the learning process, reflecting aspects of "*Learning and Innovation Skills*" within the framework of P21. Implementation of written-based aspects of communication culture *digital literacy* in schools includes the use of digital applications such as Canva and PowerPoint to create posters and presentations, as well as creating digital reports after practicums. This

approach not only develops students' written communication skills, but also enhances their *digital literacy*, in line with the findings of Sriyanto (2021) which shows that implementing *digital literacy* can improve teachers' 4C skills, including communication skills. This activity also reflects the aspect of "*Information, Media, and Technology Skills*" within the P21 framework, and prepares students to face the digital information era.

In the aspect of oral communication, which is included in "*Communication and Collaboration Skills*"In the P21 framework, Al-Abidin Surakarta ICT Elementary School students actively participate in digital presentations, class discussions, and questions and answers using various communication methods. Approach *student-centered learning* the applied one, where the teacher provokes discussion to encourage students' active participation, reflects Ye & Xu (2023) recommendations about the effectiveness of interdisciplinary thematic learning in encouraging group communication and collaboration. This is also in line with the findings of Oktavia & Ridlo (2020) which shows that the STEM approach in project-based learning can encourage students to communicate orally and improve critical thinking skills, which are part of "*Critical Thinking and Problem-Solving Skills*" in the framework of P21.

The integration of technology in Natural Sciences (IPA) learning at SD ICT Al-Abidin Surakarta shows a comprehensive approach that includes the use of digital devices and digital learning resources, representing the aspect of "*Life and Career Skills*" as well as "*Information, Media, and Technology Skills*" within the P21 framework. The use of computers, cellphones and projectors in learning, as well as the use of the internet, learning videos and digital simulations are in line with the findings of Kandel (2022) and Walan (2020) who revealed that the use of digital technology can motivate students and facilitate learning assessment. This approach also supports development of digital *literacy* students, as found by Chiu et al. (2022) that technological learning support influences development of digital *literacy* students through a theoretical perspective of self-determination.

The teaching and evaluation strategies implemented at SD ICT Al-Abidin Surakarta reflect adaptability in the digital learning context, which is in accordance with the aspect of "*Flexibility and Adaptability*"in"*Life and Career Skills*" in the P21 framework. Language adjustments made by teachers according to students' level of understanding support the development of communication skills as outlined in the framework *EL Skills & Outcomes: Communication Examples* (Scott, 2017). Evaluation of communication which includes oral and written aspects with the integration of digital applications is in line with Alifah & Sukartono (2023) recommendations regarding the importance of training students' communication skills through activities such as group discussions and presentations of creative ideas, which also reflect aspects of "*Creativity and Innovation*" in the framework of P21.

Although the implementation of learning is based on digital *literacy* at SD ICT Al-Abidin Surakarta facing several challenges, efforts to overcome these challenges reflect the aspect of "*Initiative and Self-Direction*" as well as "*Productivity and Accountability*" within the framework of P21. Challenges such as limited facilities for learning Natural Sciences (IPA) because schools are undergoing repairs, technical obstacles, and variations in students' initial skills are in line with the findings of Yefanov et al. (2020) who identified gaps in digital *literacy* between students and teachers. The school's efforts to address these challenges, including the development of more comprehensive infrastructure and the gradual introduction of digital technology, demonstrate a commitment to developing"*Life and Career Skills*" students as outlined in the P21 framework.

Overall, the cultivation of digital literacy-based communication in Natural Sciences (IPA) learning at SD ICT Al-Abidin Surakarta shows great efforts to prepare students to face the demands of the digital era, which includes all aspects of the P21 framework. This method not only helps students improve their communication skills and digital literacy, but also helps them grow in 21st century skills such as creativity and critical thinking. This is in line with the findings of Sofian et al. (2023) which emphasizes its importance *digital literacy* in facing the era of society 5.0, especially in learning science which is closely related to the development of technology. By continuing to perfect the culture-based communication strategy of digital *literacy* and overcoming existing challenges, SD ICT Al-Abidin Surakarta can further optimize the benefits of technology integration in Natural Sciences (IPA) learning, preparing students for success in the ever-growing digital era.

Implications

Based on the results and discussion in this research, the implication is that the cultivation of written and oral-based communication aspects of digital *literacy* has a positive impact in improving students' skills in organizing information, expressing ideas, and communicating effectively. Then the integration of digital technology in learning increases students' motivation and confidence in writing and presentation activities. And the use of online communication platforms facilitates interaction and collaboration between students, and encourages active participation

in class discussions. Then it is necessary to develop curriculum, learning materials and assessments that are in line with demands for digital *literacy* and 21st century skills.

Conclusion

Cultivating written-based communication aspects *digital literacy* in learning Natural Science (IPA) at SD ICT Al-Abidin Surakarta is implemented through the use of digital applications and technology-based assignments. Students actively use applications such as Canva and PowerPoint to create digital posters and presentations, as well as create practical reports in digital format. Digital-based tasks, such as crossword puzzles and poster making, are also implemented to develop skills of digital *literacy* students while remaining focused on the content Natural Science (IPA). Although there are challenges in applying writing conventions to digital assignments, this approach is effective in developing students' written communication skills in digital learning environments. Cultivating oral-based communication aspects *digital literacy* in learning Natural Science (Science) at SD ICT Al-Abidin Surakarta is implemented through digital presentations, active class discussions, and application *student-centered learning*. Students create and present presentations using PowerPoint or Canva, actively participate in class discussions, and use various communication methods such as raising their hand or speaking directly to the teacher. The teacher acts as a facilitator, provoking discussion to encourage active student participation. This approach is effective in integrating traditional communication skills with digital technology, preparing students for the communication demands of the 21st century.

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This article was write by three authors P.O., S., and A. M. The authors listed in this article contributed to the development of the article, and have read, approved the published manuscript.

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The authors declare no conflict of interest.

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