SANTRI GO DIGITAL: SEEING THE NEW FACE OF PESANTREN THAT IS SCIENCE AND TECHNOLOGY LITERATE AT AN-NAJM ISLAMIC BOARDING SCHOOL IN CENTRAL JAVA

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Abstract

This qualitative research aims to explore the implementation of the integration of science and technology at An-Najm Islamic Boarding School and its impact on the students (santri). Data were collected through in-depth interviews with caregivers, teachers, and students, participant observation, and documentation studies, then analyzed using thematic analysis. The research findings reveal that the pesantren adopted an integration strategy through a hybrid curriculum that combines classical kitab kuning learning with science-technology activities, as well as technology-based extracurricular programs such as robotics and digital content production. This implementation successfully improved the students' digital literacy while simultaneously strengthening their Islamic identity through the development of technology projects contextualized with Islamic values. Although facing infrastructure constraints and internal resistance, the pesantren was able to overcome them through collaboration with universities and a dialogical approach. This research concludes that the integration of science and technology not only transforms pesantren into dynamic educational spaces but also strengthens their role in producing a generation that is competitive yet possesses an Islamic-Indonesian character.

Keywords: *science-technology; integration; modern pesantren; digital literacy; Islamic education*

INTRODUCTION

1.1 Background

Pesantren, as the oldest Islamic educational institution in Indonesia, are often associated with the stereotype of being traditional institutions closed off to modern developments (Dhofier, 2011). This image is primarily related to the pesantren's focus on teaching the kitab kuning (classical Islamic texts) and conservative learning methods, such as *sorogan* and *bandongan*. However, in recent decades, a transformation trend has emerged in a number of pesantren that have begun to adopt a more open approach to science and technology (Jamaluddin, 2022).

The Digital Revolution 4.0 has pushed various educational institutions, including pesantren, to adapt to the demands of the times (Nurohim et al., 2023). Pesantren are no longer expected to only produce generations expert in religious sciences but are also required to respond to the needs of the digital era which emphasizes mastery of science, technology, engineering, and even digital literacy (Sari & Hidayat, 2020). For example, several pesantren have begun introducing programming, robotics, biotechnology, and digital entrepreneurship as part of their curriculum (Faisal, 2019).

Based on the description above, this research focuses on exploring more deeply how the integration of science and technology is implemented in the pesantren environment, and its impact on the competencies and perceptions of the students (santri).

1.2 Problem Formulation

Based on the background above, the problem formulation in this research is:

1. How is the implementation of the integration of science and technology at An-Najm Islamic Boarding School?
2. What is the impact of this integration on the skills and perceptions of the students (santri)?

1.3 Research Objectives

The objectives to be achieved through this research are:

1. To describe the digital transformation and integration of knowledge at An-Najm Islamic Boarding School.
2. To analyze the responses and challenges faced in the process of integrating science and technology.

LITERATURE REVIEW

2.1 Pesantren as Agent of Change

Throughout Indonesian history, pesantren have not only functioned as religious educational institutions but have also played a role as centers of social transformation (Mastuhu, 2020). According to research by Nurohim et al. (2023), pesantren have an adaptive ability that allows them to respond to changing times without losing their Islamic identity. In a contemporary context, the role of pesantren as *agents of change* is increasingly relevant with the emergence of digital society challenges.

A recent study by Faisal (2022) shows that modern pesantren are beginning to develop technology-based community empowerment models, such as digital marketing training for micro-enterprises around the pesantren. This finding strengthens previous research from Dhofier (2011) which affirmed that pesantren have a strong tradition in community empowerment. This transformation of role makes pesantren institutions that not only produce pious santri but also professionals capable of contributing to national development (Azra, 2021).

2.2 Integration of Knowledge from an Islamic Education Perspective

The concept of integration of knowledge in Islamic education has developed significantly in the last decade. According to Rahman (2020), integration of knowledge is not merely combining religious and general curricula, but building an epistemology that unites

revelation and reason within a tawhidic framework. This concept aligns with the view of al-Attas (1978) on the Islamization of knowledge, which emphasizes the importance of critical filtering of modern knowledge based on Islamic values.

Recent research by Sari et al. (2023) developed a model for integrating STEM (Science, Technology, Engineering, and Mathematics) with Islamic values in pesantren learning. This model successfully improved not only the scientific competence of the santri but also their understanding of the relationship between science and kauniyah verses (signs of God in the universe). Similar findings were reported by Jamaluddin (2022), who emphasized the importance of a transdisciplinary approach in the integration of knowledge in pesantren.

2.3 Previous Studies on Pesantren and Technology

Several studies related to pesantren and technology provide a valuable foundation for this study. A qualitative study by Hidayat & Prasetyo (2023) analyzed the implementation of digitalization in five modern pesantren in West Java and found that infrastructure readiness

and digital culture were determining factors for the success of the transformation. However, that study focused more on managerial aspects.

Another study by Wahyuni et al. (2022) examined the application of blended learning in pesantren during the pandemic and identified the main challenge in the digital competency gap of teachers. Meanwhile, an experimental study by Ahmad et al. (2023) developed an Islamic value-based robotics module for pesantren and proved a significant improvement in the computational thinking skills of the santri.

Different from previous studies which emphasized technical and curricular aspects more, this study focuses on the perceptions and experiences of educational actors (kiai, teachers, and santri) in the process of integrating science and technology. An in-depth qualitative approach is expected to reveal socio-cultural dynamics that have not been much touched upon in previous research.

RESEARCH METHOD

3.1 Research Approach and Type

This research uses a qualitative approach with a case study type. This approach was chosen because it is suitable for exploring phenomena in depth in their natural context (Creswell & Poth, 2018). The case study allows the researcher to understand the implementation of the integration of science and technology at An-Najm Islamic Boarding School holistically through the various perspectives of the involved actors.

3.2 Research Location and Subjects

The research was conducted at **An-Najm Islamic Boarding School** (pseudonym) located in Central Java. This pesantren was selected based on the following considerations:

1. Has implemented a science and technology integration program for the last five years.
2. Has a balanced curriculum between religious and general sciences.
3. Has various technology initiatives such as a robotics laboratory, podcast studio, and digital entrepreneurship program.

Research subjects were determined using **purposive sampling** technique with the following criteria:

1. **Caregiver/Kyai**: As the main policy holder.
2. **Teachers**: Those teaching science/technology and religious subjects.
3. **Santri**: Actively participating in science/technology programs (15 people from various educational levels).

3.3 Data Collection Techniques

Data collection was carried out through three main techniques:

1. **Semi-Structured Interviews**
    - Conducted with 1 caregiver, 5 teachers, and 15 santri.
    - Using an interview guide covering aspects:
        - Perceptions about science-technology integration.
        - Implementation experiences.
        - Challenges and support faced.
    - Interview duration 45-60 minutes for each participant.
2. **Participant Observation**
    - Conducted for 2 months in various settings:

        - Integrated learning classes.
        - Technology extracurricular activities.
        - Life in the dormitory and pesantren environment.
    - Focus on academic interactions and the use of technology in daily life.
3. **Documentation Study**
    - Analysis of:
        - Curriculum and learning syllabi.
        - Student work (technology projects, portfolios).
        - Photo and video documentation of activities.
        - Pesantren archives related to program development.

3.4 Data Analysis Process

Data analysis followed the thematic analysis model from Braun and Clarke (2006) through six stages:

1. **Familiarization with Data**
    - Repeatedly reading transcripts and noting initial ideas.
2. **Generating Initial Codes**
    - Assigning codes to data relevant to the research questions.
    - Example codes: "infrastructure limitations", "kiai support", "increased creativity".
3. **Searching for Themes**
    - Grouping codes with similarities into potential themes.
    - Identified themes: adaptation, challenges, benefits, institutional support.
4. **Reviewing Themes**
    - Ensuring the generated themes are relevant to the data and research questions.
5. **Defining and Naming Themes**
    - Developing a narrative for each generated theme.
6. **Producing the Report**
    - Presenting the findings in the form of a coherent narrative accompanied by direct quotes.

3.5 Data Validity Check

Data validity was maintained through:

1. **Triangulation** by comparing interview results, observation, and documentation.
2. **Member checking** by confirming data interpretation with participants.
3. **Prolonged engagement** in the field to understand the context in depth.

3.6 Research Ethics

This research adheres to the principles of research ethics:

1. **Informed consent** from all participants.
2. **Confidentiality of identity** by using pseudonyms.
3. **Principle of voluntariness** in participation.

FINDINGS AND DISCUSSION

4.1 Theme 1: Strategies for Integrating Science and Technology

Hybrid Curriculum

Based on interview results and curriculum document analysis, An-Najm Islamic Boarding School developed a **hybrid curriculum** approach that combines classical pesantren learning with modern technology content. In practice, learning the kitab kuning such as *Tafsir Al-Jalalain* is interspersed with simple science practicums. For example, when discussing kauniyah verses about the creation of the heavens, students observe celestial objects using a digital telescope.

A teacher stated:

"We want the students to understand that qauliyah verses (scriptural) and kauniyah verses (cosmic) must be read together. When studying kitab kuning, we don't stop at the text alone, but connect it with the reality of modern science" (Interview Teacher A, November 15, 2024).

Technology-Based Extracurricular Activities

This pesantren presents various technology extracurricular programs that are popular among students. **Robotics classes** and **digital content creation** are flagship activities. Observation showed the enthusiasm of students in soldering robot components and producing da'wah videos in the pesantren's mini studio. Photo documentation shows female and male students actively involved in basic coding activities using open-source software.

4.2 Theme 2: Impact on Santri

Increased Digital Literacy

Research findings reveal a significant increase in the students' **digital literacy**. They are not only able to operate technological devices but also utilize them for simple research. A 3rd-grade Madrasah Aliyah student commented:

"Now studying kitab is allowed, making animations is also allowed. We are taught to create digital presentations to present the results of our kitab kuning analysis" (Interview Santri B, November 20, 2024).

Strengthening Values through Technology

The research documented several **technology projects with Islamic nuances** developed by the students. One of them is a digital Hijri calendar application equipped with an automatic prayer schedule based on GPS. Observation showed how students used programming skills to create practical solutions for community (ummat) problems, while simultaneously strengthening their Islamic identity.

4.3 Theme 3: Challenges and Solutions

Challenges Faced

Despite showing progress, the science-technology integration in this pesantren faces several challenges. **Infrastructure limitations** were the main obstacle, especially related to unstable electricity supply and limited internet bandwidth. Additionally, there was **resistance from some internal parties** who were concerned about technology being a distraction to worship concentration.

Implemented Solutions

The pesantren responded to these challenges through **strategic collaboration** with local universities. The Yogyakarta University of Technology provided technical assistance and equipment aid. A **participatory dialogical approach** with senior kiais was also conducted

to build a shared understanding about the importance of technological adaptation.

4.4 Integrative Discussion

The findings of this research are consistent with the study by Sari et al. (2023) on STEM integration in pesantren, which emphasizes the importance of a contextual approach. The hybrid curriculum strategy implemented by An-Najm Islamic Boarding School aligns with the concept of Islamization of knowledge à la Al-Attas (1978), where religious and general sciences are viewed as an epistemological unity.

The infrastructure limitations faced also reinforce the findings of Faisal (2022) regarding the challenges of pesantren digitalization in the regions. However, what is interesting from these findings is the pesantren's ability to develop collaborative solutions involving multiple parties, showing the elasticity of the pesantren institution in adapting to changing times.

The positive impact on the students strengthens Mastuhu's (2020) thesis about the role of pesantren as an agent of change. The increase in digital literacy alongside the strengthening of Islamic values in the students proves that science-technology integration does not have to erode religious identity, but can actually strengthen it through the actualization of Islamic values in technology products.

DISCUSSION

5.1 Interpretation of Findings

Pesantren as a Dynamic Space Responding to the Times

The findings of this research refute the stereotype of pesantren as an *ivory tower* isolated from modern developments. An-Najm Islamic Boarding School instead shows a high adaptive capacity through the integration of science and technology in its curriculum. This transformation is in accordance with the theory of *adaptive resilience* in Islamic education (Nurohim et al., 2023), where pesantren not only maintain tradition but also actively respond to the challenges of the times.

This phenomenon strengthens Azra's (2021) view on the elasticity of pesantren as educational institutions. Observation shows that pesantren classrooms have transformed into *living laboratories* where kitab kuning dialogues with microscopes, and fiqh studies go hand in hand with computer programming. This shows that pesantren are no longer spectators, but active actors in the flow of modernization.

Science-Technology Integration as a Strengthener of Islamic Identity

The research findings reveal an interesting paradox: instead of eroding Islamic identity, science-technology integration actually strengthens it when contextualized with Islamic values. The projects of the Hijri calendar application and GPS-based prayer time zoning system developed by the students are concrete evidence of how technology is used to strengthen religious practice.

This phenomenon is in line with the concept of **contextualization of knowledge** developed by Rahman (2020), where knowledge is not accepted raw but is interpreted through the lens of Islamic values. The student's quote **"Now studying kitab is allowed, making animations is also allowed"** shows a positive *double consciousness* - the ability to master modern technology without losing their Islamic roots.

5.2 Relevance to the Colloquium Theme

Integration of Knowledge for Strengthening Islamic and Indonesian Identity

The findings of this research directly address the colloquium's sub-theme 2 about **integration and development of knowledge** and simultaneously sub-theme 3 about **strengthening Islamic and Indonesian identity**. The integration of science- technology in pesantren not only produces technical competencies but also shapes the identity of santri who are **glocal** - thinking globally while remaining rooted in local values.

The technology works developed by the students, such as the Hijri calendar application adjusted to the national calendar, show how Islamic and Indonesian identities can synergize. This is an actualization of the inclusive and adaptive concept of **Islam Nusantara** (Jamaluddin, 2022), where technology is used to strengthen both Islamic identity and love for the homeland.

Santri as Agents of Change in Nurturing Indonesia

Through the mastery of science-technology based on Islamic values, santri not only prepare themselves for global competence but also actively contribute to **nurturing Indonesia** (the colloquium's sub-theme 4). Technology projects that solve community (ummat) problems, such as digital zakat monitoring systems or Islamic learning applications for remote areas, show the real role of pesantren in national development.

This finding strengthens Dhofier's (2011) thesis about the dual role of pesantren as a moral fortress and an engine of development. In the context of modern Indonesia, this role is actualized through the mastery of responsible technology oriented towards the benefit of the community (ummah).

5.3 Theoretical and Practical Implications

This research provides a theoretical contribution in developing a contextual model of science-technology integration with pesantren culture. Practically, these findings can be a reference for other pesantren that want to carry out similar transformations, by paying attention to local wisdom and Islamic values.

CONCLUSION

6.1 Conclusion

Based on the research results that have been conducted, it can be concluded that An-Najm Islamic Boarding School has successfully implemented the integration of science and technology through a hybrid curriculum approach and technology-based extracurricular activities. This transformation shows the adaptive ability of pesantren in responding to the challenges of the times without losing their Islamic identity. The integration actually strengthened the students' Islamic identity when contextualized with Islamic values, as seen in technology projects that address community (ummat) problems.

This research also reveals that the main challenges lie in infrastructure limitations and internal resistance, but the pesantren was able to overcome them through strategic collaboration with universities and a dialogical approach with the kiais. These findings strengthen the role of pesantren as agents of change that not only guard tradition but also actively contribute to national development through the mastery of science and technology.

6.2 Suggestions

Based on the research findings, several suggestions are proposed as follows:

For Pesantren:

1. Develop a sustainable evaluation model to monitor the effectiveness of science-technology integration programs.

2. Strengthen collaboration with the technology industry for curriculum alignment with job market needs.
3. Create regular forums for dialogue between religious teachers and science-technology teachers in designing integrated learning.

For the Government:

1. Provide adequate technology infrastructure support for pesantren, especially in remote areas.
2. Compile guidelines for the integration of science-technology in pesantren education that are flexible and contextual.
3. Facilitate the exchange of best practices between pesantren through sister school programs.

For Further Research:

1. Similar research needs to be conducted with a broader scope and a longer time frame.
2. Deeper exploration is needed regarding models of science-technology integration suitable for different typologies of pesantren.
3. It is necessary to develop instruments to measure the impact of science-technology integration on the character formation of santri.

With proper implementation, the integration of science and technology in pesantren education is expected to produce a generation of santri who are excellent spiritually, intellectually, and technologically, and able to contribute actively in answering the challenges of national development.

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