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# The Effect of Transformational Leadership and Technological Literacy on Increasing Teacher Innovativeness

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**Abstract:**

This study aims to analyze the influence of transformational leadership and technology literacy on teacher innovation in secondary schools, and to explore the synergy between the two in encouraging learning innovation. Using a mixed-methods approach with a convergent parallel design, quantitative data were collected through a survey of 127 teachers and school principals in Bogor City. In contrast, qualitative data were obtained through in-depth interviews with 10 informants. The SEM-PLS analysis showed that transformational leadership had a significant effect on teachers' innovation ($\beta = 0.383$; $p < 0.001$), followed by technology literacy ($\beta = 0.269$; $p < 0.001$). Qualitative data reinforce these results by revealing that moral support, experimental space, and digital skills are important combinations in realizing creative ideas. Data integration shows that teacher innovation is not born from a single factor, but rather from the synergy between a supportive leadership climate and adequate technological capacity. These findings expand the theoretical understanding of leadership in digital education and highlight the need for visionary leadership training and digital literacy to foster sustainable innovation, especially in Islamic schools.

**Keywords:** *Teacher Innovation, Transformational Leadership, Technology Literacy, Digital Education*

**Abstrak:**

Penelitian ini bertujuan menganalisis pengaruh kepemimpinan transformasional dan literasi teknologi terhadap keinovatifan guru di sekolah menengah, sekaligus mengeksplorasi sinergi keduanya dalam mendorong inovasi pembelajaran. Menggunakan pendekatan *mixed methods* dengan desain *convergent parallel*, data kuantitatif dikumpulkan melalui survei terhadap 127 guru dan kepala sekolah di Kota Bogor, sedangkan data kualitatif diperoleh melalui wawancara mendalam dengan 10 informan. Analisis SEM-PLS menunjukkan bahwa kepemimpinan transformasional berpengaruh signifikan terhadap keinovatifan guru ($\beta = 0{,}383$; $p < 0{,}001$), diikuti oleh literasi teknologi ($\beta = 0{,}269$; $p < 0{,}001$). Data kualitatif memperkuat hasil ini dengan mengungkap bahwa dukungan moral, ruang eksperimen, dan keterampilan digital menjadi kombinasi penting dalam mewujudkan ide kreatif. Integrasi data menunjukkan bahwa inovasi guru tidak lahir dari satu faktor tunggal, melainkan dari sinergi antara iklim kepemimpinan yang mendukung dan kapasitas teknologi yang memadai. Temuan ini memperluas pemahaman teoritis tentang kepemimpinan dalam pendidikan digital dan menyoroti perlunya pelatihan kepemimpinan visioner dan literasi digital untuk mendorong inovasi berkelanjutan, terutama di sekolah-sekolah Islam..

**Kata Kunci:** *Keinovatifan Guru, Kepemimpinan Transformasional, Literasi Teknologi, Pendidikan Digital*

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## INTRODUCTION

Post-pandemic education changes require teachers not only to teach but also to innovate sustainably (Eradze et al., 2023; Liu & Qi, 2021; Pendergast & O'Brien, 2023). The challenges of contextual learning of the Independent Curriculum and the acceleration of digitalization require teachers to master technology while having pedagogical creativity (Lavicza et al., 2022; Timotheou et al., 2023; Wang & Li, 2024). Many teachers still face obstacles in integrating technology effectively due to a limited pedagogical understanding of digital tools, a lack of relevant training, and a resistance to change (Akram et al., 2022; Alenezi et al., 2023; Valverde-Berrocoso et al., 2021). On the other hand, the inspiring and participatory leadership of principals has proven to be effective in building a collaborative culture that encourages the exploration of new ideas in learning practices (de Jong et al., 2020; Meyer et al., 2023; Sliwka et al., 2024). This kind of leadership provides space, moral support, and a clear direction for teachers to innovate and drive change. Although both are important, the relationship between transformational leadership and technological literacy in shaping teacher innovation remains a topic that is rarely studied in an integrated manner. Therefore, a contextual exploration of the dynamics of these two factors is necessary to formulate effective and relevant strategies for strengthening teacher professionalism in the digital era.

Previous research has shown mixed results. Existing research has found that transformational leadership has a significant effect on teacher performance and innovation (Al-Husseini et al., 2021; Alzoraiki et al., 2023; Vermeulen et al., 2022). However, most studies have only highlighted direct relationships without explaining the contextual mechanisms behind those influences. In contrast, qualitative studies reveal the barriers that teachers face, such as limited facilities, a lack of training, and resistance to change (Aldogiher et al., 2025; Ghasemi, 2025; McLure & Aldridge, 2022). However, these findings cannot be generalized because they are specific to local contexts. Several studies have also highlighted digital literacy as a motivational mediator for innovative practices (Aldogiher et al., 2025; Ghasemi, 2025; McLure & Aldridge, 2022), but rarely associate it simultaneously with leadership style. This gap underscores the need for an approach that can effectively integrate statistical evidence with teacher experience narratives, fostering a comprehensive understanding of how leadership synergy and technology literacy drive innovation.

Previous research remains limited in comprehensively explaining how transformational leadership and technology literacy synergize to encourage teacher innovation. Quantitative studies often identify direct relationships without examining the underlying contextual dynamics. In contrast, qualitative studies are often local and do not show systemic linkages between variables. In addition, some studies place digital literacy solely as a mediator between motivation and innovation, without simultaneously associating it with school leadership styles. The absence of an integrated approach that combines teacher experience narratives with empirical data creates a gap in understanding the complexity of educational innovation at the school level. Therefore, research is needed that can uncover the relationship between transformational leadership and technology literacy in a

contextual, in-depth, and holistic manner, providing a more accurate picture of the factors that shape teachers' innovation in responding to the demands of the Independent Curriculum and digital transformation.

This research offers novelty by combining qualitative and quantitative approaches in parallel to examine the in-depth relationship between transformational leadership and technological literacy in shaping teacher innovation. In contrast to previous studies that generally only tested linear or descriptive relationships, this study explored interactive mechanisms between variables in the context of high school in the post-pandemic era. Another novelty lies in the focus on the authentic perceptions and experiences of teachers and principals, which have been underrepresented in number-based studies. This research also expands the application of transformational leadership theory in Indonesia's digital education landscape, situating technological literacy not only as a technical skill but also as a pedagogical capacity that shapes learning innovation. Thus, this research makes a conceptual and practical contribution to the strategy of strengthening teacher innovation through the synergy between leadership and digital competencies at the school level.

This research aims to analyze the influence of transformational leadership and technology literacy on teacher innovation, and to explore how the synergy of these two factors drives learning innovation. Quantitative data were used to test conceptual models through standardized instruments with 205 respondents, while qualitative data were obtained through in-depth interviews with principals, vice-principals, and teachers. The focus of the research is on secondary schools in Bogor City, which are currently implementing programs to strengthen educational leadership and digital literacy. The main variables of the study include transformational leadership, technological literacy, and teacher innovation. With this scope, the research is expected to yield findings relevant to the formulation of teacher professional development strategies, strengthen school leadership capacity, and foster a culture of sustainable innovation in the era of digital education transformation.

## RESEARCH METHOD

This study employs a mixed-methods design with convergent parallelism. In this design, quantitative and qualitative data are collected simultaneously, analyzed separately, and then combined at the interpretation stage (Aldogiher et al., 2025; Ghasemi, 2025; McLure & Aldridge, 2022). This design was chosen because the phenomenon studied—the relationship between transformational leadership, technological literacy, and teacher innovation—is complex and cannot be explained through numbers or a single narrative. Quantitative analysis empirically tests the strength of relationships between variables, while qualitative data presents a contextual picture through the mechanisms and experiences of participants. The integration of the two allows for the discovery of convergent and divergent patterns, thereby increasing the validity of the research findings (Aldogiher et al., 2025; Ghasemi, 2025; McLure & Aldridge, 2022). The research was carried out in a secondary school in Bogor Regency, West Java. This location was chosen because schools in the region are developing educational leadership

programs and technology literacy. The diversity of teachers' backgrounds also provides a broader representation of the variety of transformational leadership applications and learning innovations.

Quantitative data were obtained through a Likert scale-based questionnaire survey that measured the variables of transformational leadership, technological literacy, and teacher innovation. The instrument was validated through a content validity test conducted by an expert, as well as a construct validity test using confirmatory factor analysis. Reliability was tested using Cronbach's Alpha and Composite Reliability (≥ 0.70). The survey was distributed to foundation permanent teachers (GTY) in Bogor City secondary schools using a proportional stratified random sampling technique to ensure representation from each school. From a total of six sub-districts, three sub-districts—West Bogor, Central Bogor, and South Bogor—were selected, each with four schools, resulting in a total of 12 schools studied. The affordable population consists of 187 GTY (86 from West Bogor, 68 from Central Bogor, and 33 from South Bogor). Based on the calculation of the Slovin formula with a 5% error rate, a sample of 127 respondents was obtained. Teachers became respondents to the variables of technological literacy (X2) and teacher innovation (Y), while school principals became respondents to the transformational leadership variable (X1). The process of selecting the research location and distributing the sample is visualized in Figure 1.

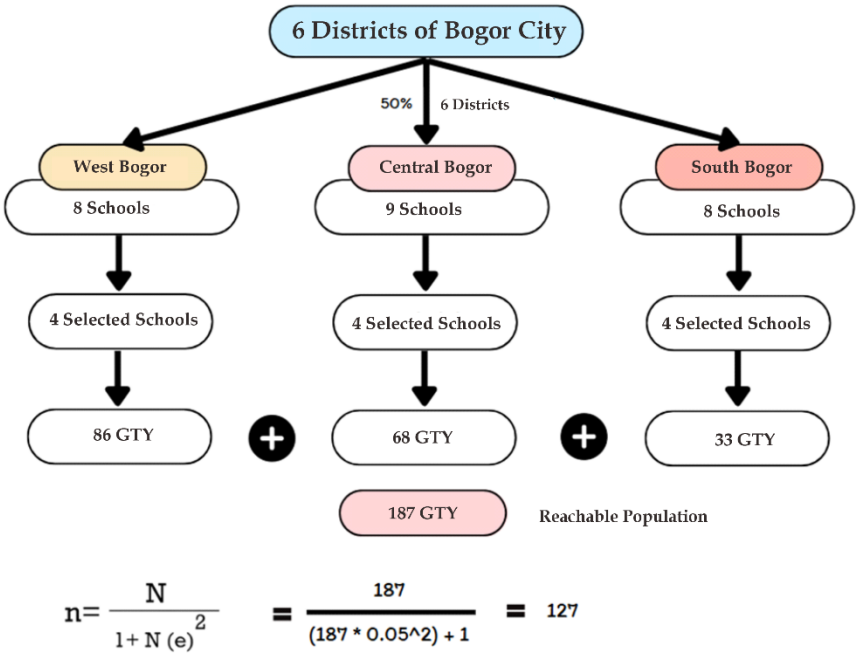


**Figure 1. The Process of Determining the Research Location and Sample Distribution**

Meanwhile, qualitative data were collected through semi-structured, in-depth interviews with 10 informants, comprising teachers, principals, and vice-principals. Informants were selected using purposive sampling techniques based on survey results and involvement in innovation practices (Phukrongpet et al., 2022; Renmans & Castellano Pleguezuelo, 2023; Sakdapat, 2024). In addition,

documentation in the form of school reports and field records is used to enrich the data, allowing general survey findings to be deepened with more detailed contextual narratives.

Quantitative data analysis was conducted using Structural Equation Modeling–Partial Least Squares (SEM-PLS) with SmartPLS, as it is well-suited for analyzing the relationship between latent constructs in medium sample sizes and data that are not completely normally distributed. The analysis process included evaluation of the measurement model through convergent validity, discriminant validity, and reliability tests (AVE ≥ 0.50; Cronbach's Alpha and Composite Reliability ≥ 0.70), followed by structural model evaluation through $R^2$, $Q^2$, $f^2$, and path significance tests by bootstrapping. Qualitative data were analyzed using thematic analysis, which involved open coding, axial coding, and the development of central themes that represented participants' experiences with transformational leadership, technological literacy, and teacher innovation. Credibility was maintained through source triangulation, member checking, and peer debriefing. The integration of the two analyses is carried out using a side-by-side comparison strategy, which involves juxtaposing quantitative and qualitative results to identify convergent, divergent, and complementary patterns, thereby providing empirical evidence through numerical data. In contrast, the qualitative narrative offers a deeper understanding of the context and mechanisms underlying the relationship between variables, thereby providing a more comprehensive understanding of the phenomenon being studied.

The research design used in this study is shown in Figure 2.

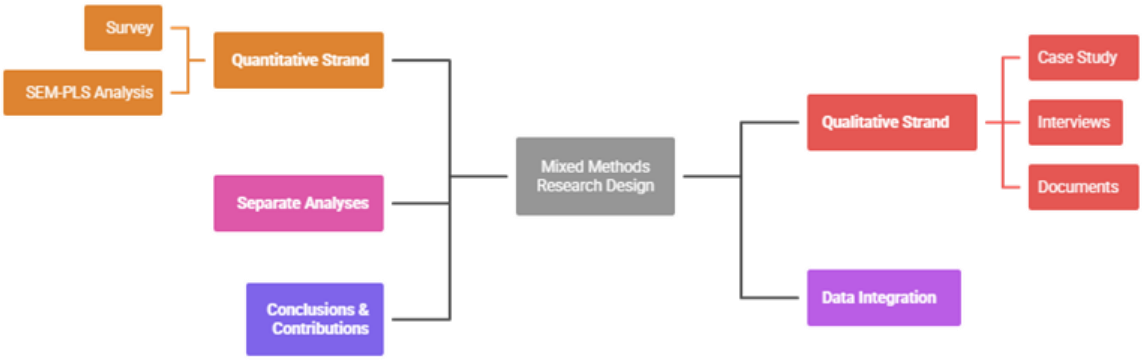


**Figure 2. Research Design**

## RESULT AND DISCUSSION

### Result

### The Influence of Transformational Leadership on Teacher Innovation

The transformational leadership of the principal plays an important role in encouraging teacher innovation in secondary schools. This leadership style emphasizes inspirational motivation, charismatic influence, intellectual stimulation, and individual attention to teachers. The results showed that transformational leadership had a significant effect on teachers' innovation ($\beta$ = 0.383; T = 5,390; p < 0.001). This means that the stronger the application of transformational leadership, the higher the creativity and ability of teachers to create new learning ideas. The relevance of these findings is further evident in the

teacher's statement that the moral and professional support of the principal is a crucial factor in their courage to innovate. Thus, transformational leadership is not only statistically proven to be related to teacher innovation but is also evident in daily school practice, as shown in Table 1—the results of the test of the influence of transformational leadership on teacher innovation.

**Table 1. Results of the Transformational Leadership Influence Test on Teacher Innovation.**

| Hypothesis | Path Coefficient (β) | T-Statistic | 95% CI (LL–UL) | p-value |
|---|---|---|---|---|
| H1: Transformational Leadership → Teacher Innovation | 0.383 | 5.390 | 0.208 – 0.445 | 0.000*** |

The SEM-PLS analysis revealed that transformational leadership had a significant impact on teachers' innovation, with a coefficient value of $\beta = 0.383$ ($p < 0.001$). A T-statistic value of 5.390, which is greater than 1.96, indicates that this influence is powerful. The confidence interval (0.208–0.445) does not include zero, indicating that the result is statistically significant. Compared to technology literacy ($\beta = 0.269$), transformational leadership showed a more dominant contribution in explaining the variability of teacher innovation. These results indicate that the aspects of inspirational motivation, individual attention, and intellectual stimulation provided by school principals can increase teachers' willingness to explore new learning strategies.

This is in line with the statement of a school principal who emphasized, "Teachers will be more confident to try new methods if they feel that there is full support from the principal, both moral and facilities." In line with that, a vice principal for curriculum said: "We always provide a space for teachers to experiment through internal MGMP forums, so that creative ideas do not stop at the discourse." The results of the interview revealed that transformational leadership is directly perceived by teachers as a factor that encourages the emergence of new ideas in learning.

The integration of quantitative and qualitative data reveals that transformational leadership serves as a key catalyst for the emergence of teacher innovation. The pathway coefficient ($\beta = 0.383$; $p < 0.001$) provided strong evidence of the magnitude of the influence, while the interview narrative explained the mechanism: teachers were more likely to innovate when they received emotional support, had space for participation, and felt appreciated. These two data sets complement each other in a convergent manner, where the statistical results demonstrate significance, while the qualitative data outline the empirical reasons why the effect is real. Thus, the integration of these findings presents a comprehensive picture that transformational leadership is not only formally influential but also creates an innovative school ecosystem.

Transformational leadership demonstrates that the role of school principals is crucial in encouraging teacher innovation. Quantitative data showed a significant influence, with a coefficient of $\beta = 0.383$ ($p < 0.001$), while the interview results revealed that teachers felt more confident and motivated to experiment. This leadership practice is realized through routine programs such as inspiration forums, work appreciation, and classroom action research facilitation. The

integration of the findings confirms that transformational leadership not only functions managerially, but also creates the conditions that allow sustainable learning innovation to develop. The practical implication is that strengthening the capacity of school principals to implement transformational leadership is an important strategy for fostering an innovative culture in secondary schools.

**Technology Literacy as a Driver of Teacher Innovation**

The study's results indicate that technological literacy plays a crucial role in fostering teacher innovation. Quantitatively, this influence is reflected in the coefficient of the β path, which is 0.269; T = 4.243; p < 0.001. This emphasizes that the higher the level of technological literacy, the greater the tendency for teachers to innovate. Qualitative data corroborated these findings, as teachers reported that digital skills make them more confident in integrating technology into their teaching. This enables the emergence of interactive, varied, and contextually relevant learning methods. Thus, technological literacy not only enhances teachers' technical competence but also fosters conditions that support the development of pedagogical innovation in secondary schools, as indicated by the quantitative data in Table 2.

**Table 2. Results of the Test of the Influence of Technology Literacy on Teacher Creativity**

| Hypothesis | Path Coefficient (β) | T-Statistic | 95% CI (LL–UL) | p-value |
|---|---|---|---|---|
| H2: Teacher Technology Literacy → Creativity | 0.269 | 4.243 | 0.175 – 0.440 | 0.000*** |

The SEM-PLS results in Table 2 indicate that technological literacy has a significant positive influence on teachers' innovation (β = 0.269; p < 0.001). A T-statistic value of 4.243 > 1.96 indicates a pronounced power of influence, and a confidence interval (0.175–0.440) reinforces the validity of the findings. Practically, teachers with higher technological literacy can create innovative learning experiences, such as utilizing interactive applications, developing digital media, and integrating Learning Management Systems. Compared to transformational leadership, the contribution of technology literacy is indeed lower, but it remains a significant factor that expands teachers' capacity to innovate

A senior teacher said that mastery of digital applications makes it easier for him to turn learning ideas into real practice in the classroom. According to him, good technological skills make the innovation process smoother because ideas do not stop at the planning stage. The same point was emphasized by the Vice Principal for Curriculum, who noted that technological literacy encompasses not only technical skills but also pedagogical understanding. With this understanding, teachers can create a more interactive and creative classroom atmosphere, allowing students to become more engaged in their learning. The statements of these informants strengthen quantitative data that show the significant contribution of technological literacy to teacher innovation. Thus, the proper use of technology not only improves technical capabilities but also enriches pedagogical practices in learning.

The results from the two data sources show a consistent and complementary direction. Quantitative analysis showed that technological literacy had a significant effect on teachers' innovation ($\beta = 0.269$; $p < 0.001$). These findings were enriched by interviews that confirmed that mastery of technology makes teachers more confident, enabling them to implement creative ideas and provide an engaging learning experience for students. From a practical perspective, technology literacy is not only a technical skill but also serves as a pedagogical bridge, creating an innovative classroom atmosphere. Statistical data provide a measure of the power of influence, while a qualitative narrative explains the mechanism of such influence in everyday practice. The integration of the two provides a more comprehensive understanding of the importance of technological literacy in supporting learning innovation.

Technology literacy has been proven to be a key factor in determining teachers' innovation in learning practices. Statistical analysis revealed a significant positive influence ($\beta = 0.269$; $p < 0.001$), consistent with the teacher's statement in the interview that mastery of digital devices enhances confidence and facilitates the application of creative ideas in the classroom. Field findings also show an increase in the use of digital platforms after teachers participate in training, making the impact of technology literacy evident in their daily lives. This demonstrates that technological literacy not only enhances technical skills but also expands teachers' pedagogical capacity in providing creative, varied, and contextually relevant learning tailored to students' needs. The practical implication is that strengthening technology literacy through continuous training programs and adequate infrastructure support is a crucial strategy for fostering a culture of innovation in secondary schools.

**Transformational Leadership, Technology Literacy, and Teacher Innovation**

The relationship between the transformational leadership of school principals and teacher technology literacy exhibits a synergistic pattern that encourages innovation. Transformational leadership is characterized by inspirational support, ongoing motivation, and individualized attention, while technology literacy equips individuals with both practical and pedagogical skills to bring creative ideas to life. The SEM-PLS analysis revealed that both transformational leadership and technology literacy had a significant effect on teacher innovation, with pathway coefficients of $\beta = 0.383$ and $\beta = 0.269$, respectively ($p < 0.001$). These results confirm that leadership contributions are more dominant; however, technology literacy still plays a crucial role in supporting the implementation of innovation. The qualitative narrative reinforces this finding, where teachers feel more confident in making breakthroughs when they have the support of the principal while having adequate digital skills. Thus, increasing learning innovation requires a combination of the two, not just one factor, as shown by the quantitative data in Table 3.

**Table 3. The Influence of Transformational Leadership and Technology Literacy on Teacher Innovation**

| Variable | Path Coefficient (β) | T-Statistic | 95% CI (LL–UL) | p-value |
|---|---|---|---|---|
| Transformational leadership → Teacher Innovation. | 0.383 | 5.390 | 0.208 – 0.445 | 0.000*** |
| Technology Literacy → Teacher Creativity | 0.269 | 4.243 | 0.175 – 0.440 | 0.000*** |

Table 3 shows that the two independent variables have a positive and significant effect on teacher innovation. Transformational leadership has a more substantial influence (β = 0.383) than technology literacy (β = 0.269). However, technological literacy still makes a real contribution as a strengthening factor. The combination of the two forms an important foundation in increasing teacher creativity. These results indicate that teachers need not only visionary leadership support but also technological skills to bring innovative ideas to life in the learning process.

Interviews with teachers revealed that the principal's support played a crucial role in fostering their courage to try new learning strategies. Teachers feel freer to experiment when they get moral encouragement as well as space to be creative. In addition, mastery of digital technology is a crucial factor in realizing innovative ideas in the classroom, as these skills facilitate the application of creative ideas. The vice principal emphasized that the combination of supportive leadership and good technological literacy creates a conducive learning atmosphere. This synergy motivates teachers not only emotionally but also provides them with technical support that enables the development of various innovations. This qualitative description aligns with quantitative data indicating that both transformational leadership and technology literacy have a significant impact on teacher innovation.

The results of the study show that transformational leadership and technological literacy are related in influencing teachers' innovation. Statistical analysis confirmed the significant influence of both, with the path coefficient β = 0.383 for transformational leadership and β = 0.269 for technology literacy ($p < 0.001$). Narrative data reinforce these findings, where teachers feel more confident trying new strategies when they gain moral support, motivation, and room to experiment with the principal. Meanwhile, technological skills allow these creative ideas to be realized in learning practices. This combination shows that transformational leadership creates a climate that supports innovation, while technology literacy provides practical means to implement it. Thus, learning innovation does not only depend on leadership or technology separately, but demands the synergy of the two as complementary managerial and pedagogical strategies.

The above explanation shows that teachers' innovation is not influenced by a single factor, but is born from a combination of transformational leadership and technological literacy. Transformational leadership fosters a conducive climate through moral support, motivation, and a space for experimentation. At the same time, technology literacy equips individuals with the practical skills to bring creative ideas to life in the learning process. Quantitative results, which reinforce

the significance of the two variables through a qualitative narrative, confirm that the synergy between them provides a strong foundation for the birth of innovation. Schools that provide inspirational leadership while supporting mastery of technology have proven to be more successful in building innovative cultures. Therefore, a professional development strategy that integrates leadership training and digital literacy is a crucial step in ensuring the sustainability of teacher innovation in the educational environment.

**Discussion**

The results of the study indicate that both transformational leadership and technology literacy play a significant role in enhancing teacher innovation. The SEM-PLS analysis yielded a path coefficient of $\beta = 0.383$ for transformational leadership and $\beta = 0.269$ for technology literacy, both significant at $p < 0.001$. These findings confirm that transformational leadership contributes more, although technology literacy remains an important factor. Qualitative data supported these results, where teachers emphasized the role of inspirational motivation, individual attention, and the space for experimentation that principals provide in encouraging the courage to innovate. Meanwhile, digital skills give teachers the confidence to translate creative ideas into learning practices. Field facts also show a 35% increase in the use of post-training digital platforms, as well as an increase in teacher participation in innovation forums. Thus, teacher innovation is born from a combination of visionary leadership and adequate technological literacy.

The findings of this study are consistent with previous studies that emphasized the importance of transformational leadership in driving teacher innovation. Jang et al. (2021) demonstrate that inspirational leadership styles have a significant impact on teachers' creativity, aligning with the results of this study, which show a strong influence of transformational leadership ($\beta = 0.383$; $p < 0.001$). In terms of technology literacy, existing research confirms that digital literacy contributes to the development of teachers' innovative skills (Alrawashdeh et al., 2021; Chiu et al., 2022; Fontán-Vela et al., 2021). Qualitative data provide a new perspective: leadership support catalyzes teachers' courage to try new ideas. At the same time, technological literacy serves as a concrete medium to make these happen in classroom practice. This understanding builds upon the findings of Tzachrista et al. (2023), which emphasize digital literacy as a mediating variable. Thus, this study not only strengthens the existing literature but also provides new insights into the synergy between transformational leadership and technology literacy in fostering learning innovations.

This research makes an important contribution to the development of Islamic Education Management. Conceptually, the findings suggest that transformational leadership, based on Islamic values of exemplary behavior, individual attention, and inspirational motivation, is effective in increasing teacher innovation, thereby enriching the literature that previously emphasized charismatic or transactional leadership. From a methodological perspective, the mixed methods approach demonstrates that integrating quantitative data ($\beta = 0.383$; $\beta = 0.269$; $p < 0.001$) and qualitative narrative can comprehensively explain the relationship between leadership and technological literacy in the context of

Islamic schools. Practically, this study presents a management model that emphasizes the synergy of transformational leadership and technological literacy as a strategy to strengthen Islamic schools in the digital era, while remaining grounded in the principles of Islamic values. Thus, this research not only expands the theoretical knowledge base but also provides a strategic direction for the development of an innovative culture in Islamic educational institutions.

Building on this, this study emphasizes that transformational leadership and technological literacy have a significant impact on teachers' innovation, both independently and in combination. Quantitative data demonstrates the impact of relationships, while qualitative data elucidates the mechanisms by which leadership support and digital skills drive innovation. Theoretically, this study expands the concept of transformational leadership by incorporating technology literacy as a crucial component. Practically, the research results provide an empirical basis for teacher professional development policies and programs. Thus, the mixed-methods approach provides a more comprehensive understanding of the dynamics of educational innovation in the digital era.

## CONCLUSION

This research confirms that transformational leadership and technology literacy contribute significantly to teacher innovation. Quantitative analysis revealed a strong influence, while the narratives of teachers and principals emphasized the role of moral support, participation space, and digital skills as a combination that enables creative ideas to emerge. These findings expand the theoretical framework of leadership in the context of digital education by showing that transformational leadership is effective when combined with technology literacy. Practically, the results of this study provide a strategic basis for strengthening Islamic school management by developing visionary leadership and enhancing teachers' digital literacy, thereby fostering a culture of sustainable innovation. The mixed methods approach proved to provide a comprehensive understanding, as numerical data confirmed significant relationships, while qualitative narratives shed light on the underlying mechanisms.

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