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

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Abstract

In the era of digital disruption, teacher innovativeness has become a crucial element in enhancing the quality of adaptive and meaningful learning. This study aims to analyze the influence of transformational leadership and technological literacy on teacher innovativeness at the senior high school level. Employing a *mixed methods* approach, the initial exploratory phase involved interviews with school principals and vice principals to identify key influencing variables. The subsequent quantitative phase tested the conceptual model using validated and reliable instruments distributed to 205 respondents, with data analyzed through SEM-PLS.

The results indicate that transformational leadership significantly affects teacher innovativeness (path coefficient = 0.383; $p < 0.05$), particularly through the dimensions of inspirational motivation, charismatic influence, and individualized consideration. Technological literacy also shows a significant influence (path coefficient = 0.269; $p < 0.05$), especially in basic technology use and pedagogical understanding. Further analysis using the SITOREM method recommends structured capacity-building for principals and tiered digital literacy training to enhance teacher innovation.

This research concludes that the synergy between transformational leadership and technological literacy forms the foundation for empowering teachers to develop innovative and contextual learning. The practical implications serve as a basis for designing professional development programs and strengthening school leadership as agents of educational transformation.

Keywords: *Teacher Innovativeness, Transformational Leadership, Technological Literacy Digital Education Instructional Innovation.*

I. INTRODUCTION

In the ever-evolving era of digital disruption, the world of education faces increasingly complex and dynamic challenges. Teachers, as the frontline in the learning process, are required to not only master content and pedagogy, but also have the ability to innovate, adapt to technological developments, and create relevant and meaningful learning experiences for students. Teacher innovativeness, which includes the ability to create and implement new ideas in the learning process, is a crucial element in improving the quality of education, especially in the post-COVID-19 pandemic context that has accelerated digital transformation in schools (Hutauruk & Gultom, 2021).

Teacher innovativeness is not only born from internal factors such as personal creativity or motivation, but is also strongly influenced by external contexts, including the principal's leadership style and the level of technological literacy possessed by teachers. In recent years, there has been an increasing trend of attention to the role of transformational leadership in driving teacher performance and innovativeness. Transformational leaders are able to motivate teachers to go beyond their limits, create a shared vision, provide inspirational influence, and support teachers' personal development (Susanto & Syahril, 2022). This leadership style is essential in creating a school climate that supports the exploration of new ideas and the implementation of innovations in learning.

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On the other hand, the rapid development of educational technology is both an opportunity and a challenge for teachers. Technological literacy is now not only considered an additional competency, but an integral part of teacher professionalism. This literacy includes the ability to select, understand, adapt and integrate technology in the learning process effectively. Teachers who have high technological literacy will be able to utilize Learning Management System (LMS), interactive media, collaborative digital platforms, and other learning support applications to create a more interesting and effective learning experience (Purwanto et al., 2020).

Unfortunately, not all teachers have adequate digital literacy. A national survey by the Ministry of Education, Culture, Research and Technology (Kemendikbudristek) through the Merdeka Mengajar Platform program in 2022 showed that there are still many teachers who feel less confident in integrating technology into the teaching and learning process. This shows that technological literacy has not been fully distributed and needs to be encouraged through continuous training and systemic support from school leaders.

The synergy between transformational leadership and technological literacy is believed to be a driving force in increasing teacher innovativeness. Principals who are visionary, open to change and provide space for teachers to be creative will create a work environment that supports technology exploration and learning innovation. In a study conducted by Fitria, Sumarsono, and Triatmanto (2021), it was found that principals' transformational leadership has a significant effect on teachers' morale and innovation at the secondary school level. Meanwhile, digital literacy proved to be a mediator that strengthens the relationship between work motivation and teachers' innovative practices (Sagala et al., 2021).

In addition, the results of a study by Sari et al. (2023) mentioned that teachers who have high digital literacy skills tend to be more creative in using project-based learning technology and blended learning. This shows that technological literacy acts as an enabler in realizing innovative and adaptive learning. However, such literacy will only be optimal if it is combined with supportive, inspiring and participatory leadership.

Teacher innovativeness becomes increasingly important in the context of implementing the Merdeka Curriculum, which encourages differentiated, project-based, and contextual learning. Teachers are required not only to be facilitators, but also innovators who are able to design learning according to student needs and the challenges of the times. Various obstacles such as limited facilities, lack of training, and resistance to change are still obstacles in the field (Rahman & Novitasari, 2022).

While several studies have examined the relationship between leadership and teacher performance, or between technological literacy and learning innovation, not many studies have simultaneously examined the effect of transformational leadership and technological literacy on teacher innovativeness, especially at the secondary education level and in the post-pandemic context. Therefore, this study is important to fill the gap in the literature and provide an empirical picture of the key factors that influence teacher innovativeness.

➢ *This study aims to:*

- Analyzing the effect of transformational leadership on teacher innovativeness.
- Analyzing the effect of technological literacy on teacher innovativeness.
- Find out the extent to which the combination of the two can increase teacher innovativeness in the secondary school environment.

The results of this study are expected to make theoretical and practical contributions, both for education policy makers, school managers, and teachers themselves. Theoretically, this research will enrich the literature on the factors driving teacher innovation. Practically, the results of this study can be used to design teacher professional development programs oriented towards improving technological literacy and strengthening the role of school principals as transformational leaders

II. METHODS

This research uses a mixed methods approach, which combines the strengths of qualitative and quantitative data to obtain a full and in-depth understanding of the factors that influence teacher innovativeness. This approach was chosen to capture the complexity of the phenomenon of innovation in education that cannot be fully explained with only one type of data.

➢ *Qualitative Stage: Initial Exploration:*

In the initial stage, this research used exploratory qualitative methods to explore variables relevant to teacher innovativeness. Data were collected through semi-structured interviews with principals and vice principals for curriculum in several private senior high schools in Bogor City. The interviews aimed to find out what factors have been influencing the level of teacher innovation in schools, both in terms of personal, institutional and technology.

The information obtained from the interviews was then reviewed in depth and communicated with education experts, especially lecturers and practitioners who are experts in educational leadership and learning technology. This communication process was conducted through limited panel discussions and correspondence, in order to obtain the initial constellation of the research model, which contains the relationships between variables that are considered relevant.

The results of this exploration stage determined that teacher innovativeness (Y) is influenced by several

independent variables, namely transformational leadership (X1), and technological literacy (X2).

➢ *Quantitative Stage: Model and Hypothesis Testing:*

After the research variables are identified and the conceptual model is established, the research proceeds to the quantitative stage. The research instrument in the form of a questionnaire is prepared based on indicators relevant to each variable. Before being used in the main research, the instrument was tested (try out) on 30 teachers who became the unit of analysis, to ensure the validity and reliability of the instrument items.

The item validity test was conducted by looking at the item-total correlation value, while the reliability test used the Cronbach's Alpha value with a minimum limit of ≥ 0.70 as an indicator of a reliable instrument. The trial results show that all instruments meet the criteria of valid and reliable, so they can be used in the main data collection.

➢ *Population and Sample*

The population in this study included all teachers and principals at the senior high school level in Bogor City. Sampling was done proportionally from schools spread across 6 different sub-districts. Based on calculations using the Taro Yamane formula, with a precision level of 5%, a sample size of 205 respondents was obtained.

- *The roles of the respondents were differentiated as follows:*

✓ Teachers became respondents for variable instruments: technological literacy (X2), and teacher innovativeness (Y).
✓ The principal is the respondent for the variable instrument: transformational leadership (X1).

➢ *Data Analysis Technique:*

The collected data were analyzed using two software tools, namely the latest version of SPSS and SmartPLS (SEM-PLS). SPSS was used to test initial validity and reliability as well as data description. Meanwhile, Structural Equation Modeling-Partial Least Squares (SEM-PLS) was used to test the structural model and relationships between variables in the research model.

SEM-PLS was chosen because of its ability to handle complex models, medium-sized samples, and be able to analyze latent relationships between variables with a high degree of flexibility. SEM-PLS analysis also allows researchers to test the outer model (convergent and discriminant validity), inner model (R^2 test and influence between variables), and significance test through bootstrapping.

III. FINDINGS AND DISCUSSION

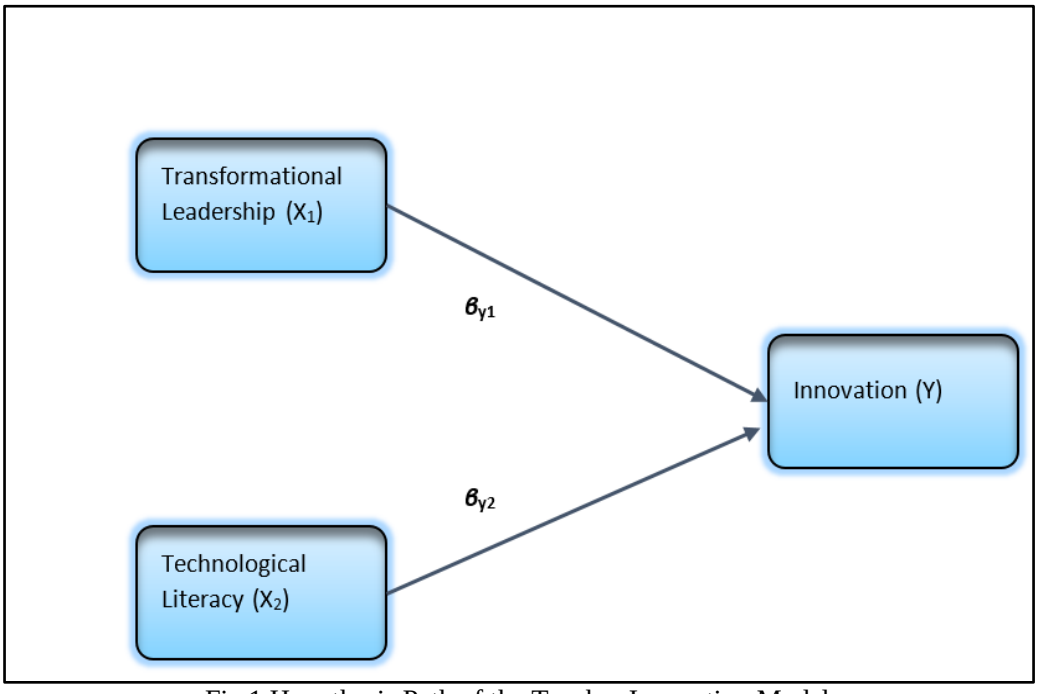

Fig 1 Hypothesis Path of the Teacher Innovation Model

Table 1 Hypothesis Testing of Direct Influence

Hypothesis	Path Coefficient	T Statistic	95% Confidence Interval Path Coefficient		p-value
			Lower Limit	Upper Limit	
H1. $X_1 \rightarrow Y$	0.383	5.390	0.208	0.445	0.000
H2. $X_2 \rightarrow Y$	0.269	4.243	0.175	0.44	0.000

Research Findings should be clear and concise. The results should summarize (scientific) findings rather than providing data in great detail. Please highlight differences between your results or findings and the previous publications by other researchers.

Based on Table 1, the first hypothesis (H1) states that there is a direct effect of variable $X_{(1)}$ (Transformational Leadership) on variable Y (Teacher Innovativeness). The analysis results show a *path coefficient* of 0.383, a T-statistic of 5.390 (greater than 1.96), and a *p-value* of 0.000 (<0.05), indicating that this effect is statistically significant. The 95% confidence interval of the path coefficient is between 0.208 to 0.445, which does not cross zero, indicating that the effect is real.

This finding supports that the stronger the transformational leadership exercised by the principal, the higher the level of teacher innovativeness. Transformational leadership that emphasizes inspiration, motivation, individual attention, and intellectual stimulation encourages teachers to be more open to change, explore new learning strategies, and develop their potential optimally (Bass & Avolio, 1994). In addition, research by Gumus et al. (2018) revealed that principals who adopt a transformational leadership style are able to create a collaborative and supportive work environment that plays an important role in encouraging innovation among teachers. The results of this study indicate that transformational school leaders are not only role models, but also facilitators in the continuous learning process, which ultimately increases teachers' spirit of innovation. This is reinforced by the findings of Nguyen et al. (2021) which states that transformational leadership style is very effective in facilitating teachers' professional growth in the digital era.

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The path coefficient value of 0.327 indicates that transformational leadership has a positive and significant direct influence on teacher innovativeness. This means that the higher the application of transformational leadership by the principal, the higher the level of teacher innovativeness in carrying out their tasks.

Based on SITOREM analysis, to strengthen the transformational leadership variable, a series of structured and sustainable concrete efforts are needed, especially on the three main indicators that are prioritized, namely providing inspiration, influencing charismatically, and paying attention to and understanding the needs of members. In an effort to improve the principal's ability to inspire, it can be done through organizing regular forums such as *weekly briefing* or *monthly inspiration talk* which serves as a forum to convey the school's vision, share inspirational stories, and appreciate individual and team achievements. Principals also need to develop and socialize school development plans that are visionary and involve active participation from teachers, so that teachers feel they have a common direction and purpose. In addition, open appreciation to teachers who succeed in creating learning innovations will encourage intrinsic motivation as well as being a source of inspiration for other teachers.

In terms of charismatic influence, the principal must be a real role model in work ethic, integrity and discipline. This attitude will build trust and respect from teachers and education personnel. Warm, humble and empathic interpersonal communication is also important to develop so that principals are able to establish positive emotional closeness. Moreover, consistency between words and actions in policy making will strengthen the credibility and legitimacy of the leadership carried out.

Furthermore, on the indicator of paying attention to and understanding the needs of members, principals are advised to actively conduct surveys or open discussions to explore the professional and emotional needs of teachers, both related to workload, training, and welfare. In addition, providing consultation rooms and individualized mentoring will be an effective tool for teachers who face challenges in the learning process or career development. Involving teachers in the decision-making process is also an important strategy so that teachers feel valued and their contributions are recognized in the process of school progress.

As for indicators that have been categorized as maintained or developed, namely improving the intellectual abilities of subordinates, efforts that can be made include encouraging teachers to actively participate in training, webinars, and scientific forums both at the local and national levels. Principals can also provide facilities and support for conducting classroom action research (PTK), writing scientific publications, or collaborating on innovative curriculum development. In addition, the establishment of *teacher learning communities* will be an effective platform to encourage a culture of sharing knowledge, skills and joint reflection on learning practices. Thus, transformational leadership does not only grow in symbolism, but is also deeply rooted in

real practice and alignment towards teachers' professional development.

Based on the explanation above, it can be concluded that strengthening transformational leadership in school principals is an important factor in encouraging sustainable improvement in teacher innovativeness.

Based on the results of the second hypothesis test (H2), it was found that technological literacy (X_2) has a positive and significant influence on teacher innovativeness (Y). The analysis shows a *path coefficient* value of 0.269, with a T-statistic of 4.243, and a p-value of 0.000, which is smaller than the 0.05 significance threshold. This indicates that increasing technological literacy in teachers significantly encourages an increase in innovative behavior in the learning process.

This finding is in line with research by Windarningsih et al. (2021), which shows that digital literacy contributes positively to teacher innovativeness. In the study, teachers who have good digital literacy are able to integrate technology in learning, thus creating a more interactive and effective learning environment. In addition, research by Setyaningsih et al. (2019) also supports these results, stating that teachers who master information technology can provide students with up-to-date and contextualized materials and create innovative learning strategies.

Based on the results of the SITOREM analysis, to strengthen the technological literacy variable, concrete steps are needed that are directed at increasing the mastery of basic technological functions and a fundamental understanding of technological concepts among teachers. The results show that the indicators of the use of basic technology and understanding of technological concepts are still relatively weak, so they require special attention. One of the strategies that can be implemented is to regularly organize basic technology training, such as training in the operation of Microsoft Office software, Google Workspace for Education, and interactive learning applications such as Canva, Quizizz, and Kahoot! This training needs to be adjusted to the level of mastery of teachers, by dividing them into beginner, intermediate and advanced classes, so that the adaptation process becomes more focused and inclusive.

Furthermore, to build a deeper understanding of technology concepts, schools can facilitate reflective discussions or teacher learning forums, such as internal MGMP or *teacher sharing* sessions, that discuss the basic principles of the appropriate application of technology. The focus is not only on the technical aspects of use, but also on the pedagogical reasons behind the utilization of technology in learning. This strategy will strengthen teachers' awareness of the role of technology as a learning tool, not just a digital trend.

Meanwhile, indicators that have shown good results, namely understanding the role of technology in learning and the ability to utilize technology for problem solving, need to be maintained and developed through more innovative approaches. Schools can provide platforms for technological experimentation and *innovation* such as *innovation labs* or digital laboratories that allow teachers to try out and evaluate various digital learning platforms independently. Awards such as technology-based *teaching innovation awards* can also encourage competitive spirit and increase teachers' digital exploration.

Finally, strengthening technological literacy depends not only on teachers but also on school leadership that is able to create an adaptive digital learning ecosystem. This includes providing adequate digital infrastructure, stable internet access, and moral and material support for teachers who continue to transform in the face of the digital learning era. With a combination of capacity building, system support and a conducive innovative culture, teachers' technological literacy can grow significantly and have a direct impact on increasing innovativeness in the learning process.

IV. CONCLUSION

Based on the results of hypothesis testing and in-depth analysis, it can be concluded that transformational leadership and technological literacy have a positive and significant influence on teacher innovativeness. Principal's transformational leadership is proven to be the dominant factor that encourages teachers to innovate, especially through the dimensions of intellectual stimulation, inspiration, and individualized attention. Exemplary, empathic communication, and teacher involvement in decision-making are key elements in shaping a work climate that supports innovation.

In addition, teachers' technological literacy also plays an important role in facilitating an innovative learning process that is relevant to the demands of the digital era. Improving the ability to operate basic technology, understand technological concepts pedagogically, and utilize digital platforms for problem solving has been proven to strengthen teacher innovativeness. Efforts to strengthen this literacy need to be accompanied by structured training strategies, good practice sharing forums and digital infrastructure support from schools.

Thus, the combination of inspiring transformational leadership and mastery of technology creates a strong synergy in building a culture of innovation in the school environment. The implications of these findings underscore the importance of strengthening the capacity of school principals as agents of change, as well as providing systemic and sustainable support for teachers in facing the challenges of 21st century education

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