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Analysis Of Internal and External Factors Contributing to The Learning Outcomes of Mathematics Education Students in The Society 5.0 Era

Muh Fajar Fazriansyah¹, Ikhsan Faturohman²

¹ Universitas Cipasung Tasikmalaya; muhfajarfazriansyah@uncip.ac.id

² Universitas Cipasung Tasikmalaya; ikhsanfaturohman@uncip.ac.id

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ABSTRACT

This study was motivated by the need to understand the factors contributing to mathematics education students' learning outcomes in the Society 5.0 era, which is characterized by advanced technology integration and rapid social changes. The purpose of this research was to analyze the influence of internal factors (learning motivation, independence, and self-management), external factors (quality of digital learning, environmental support, technological facilities, and lecturer competence), and the dynamics of Society 5.0 on students' academic achievement. This research employed a mixed-method approach with a sequential explanatory design, involving 240 students for quantitative analysis using SEM-PLS and 30 students for qualitative analysis through semi-structured interviews. The results indicated that internal factors had the most dominant influence on learning outcomes, particularly learning motivation. External factors also had a significant impact, especially the quality of digital learning, while technological development was identified as the strongest indicator of the Society 5.0 construct. However, Society 5.0 did not act as a moderator between internal and external factors and learning outcomes. The qualitative findings reinforced these results by highlighting the importance of motivation, independence, and self-management, and revealed additional factors such as health, psychological conditions, self-confidence, and economic status that affect academic performance. The study concludes that students' learning outcomes are largely determined by the synergy between internal strengths and external support, while Society 5.0 serves as a contextual framework that provides both opportunities and challenges for the learning process.

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Corresponding Author:

Muh Fajar Fazriansyah

Universitas Cipasung Tasikmalaya; muhfajarfazriansyah@uncip.ac.id

1. INTRODUCTION

The emergence of the Society 5.0 trend has led to indirect implications that enable Indonesia, as a developing country, to play a proactive role in preparing for the future trajectory of this transformative era (Daffa Faqiha Fawwaz Hanjowo, Athahirah, Febrianto Saputra, Al-Farisi, & Wijaya Abdul Rozaq, 2023; Rohayati & Abdillah, 2024). In the Society 5.0 era, characterized by the integration of the physical and digital worlds, profound changes occur across all aspects of life, including education (Maulidiya & Indriani, 2024; Sugiarto & Farid, 2023). Higher education institutions, as one of the key entities contributing to the educational sector in Indonesia, must possess the capability to adapt to various emerging trends, including those driven by Society 5.0 (Daffa Faqiha Fawwaz Hanjowo et al., 2023; Suharyati et al., 2024). The primary focus of education has shifted from mere knowledge acquisition to the development of adaptability, creativity, and critical thinking skills (Loughland, 2019; McKinnon, 2013). The rapid transformation of the educational environment ranging from the use of advanced technologies to evolving social structures has reshaped the ways in which students acquire, process, and apply knowledge (Bondac & Hrestic, 2023; Scott, 2023).

Education serves as a fundamental pillar of national progress (Khurana, 2014; Mehnatfar, 2012; Pal, 2023; Vetrova, Kabanova, Lipchenko, Savvateev, & Zubtsova, 2022). The quality of education provided by higher education institutions plays a pivotal role in shaping the future of younger generations and, more broadly, in influencing a nation's economic growth (Jovanović, 2023). Students' academic achievements are a primary indicator of educational system effectiveness (Manurung, 2017). However, behind every score or accomplishment lie numerous factors that shape students' learning outcomes. Internal factors are among those that significantly influence learning performance, including learning motivation, self-regulation, and self-management. Conversely, external factors such as the quality of digital learning, environmental support, technological facilities, and lecturer competence also play a crucial role in determining academic achievement (Fasya, Nurdin, & Suroto, 2023; Mahardhika, Jusuf, Santoso, Alexander, & Nuruhidin, 2023; Maulani et al., 2024; Ningsih, Suroyo, & Tatminingsih, 2022; Wati & Afifah, 2023). Therefore, understanding the factors that affect students' learning outcomes is essential for optimizing learning processes in the Society 5.0 era and ensuring that each student can achieve their fullest potential.

Research on the factors influencing students' learning outcomes has gained significant attention in recent years. These factors are generally categorized into internal and external domains. Internal factors include discipline, learning motivation, self-management, and adaptability to learning environments (Hapsari & Vanadian, 2022). Such factors positively influence students' learning outcomes as they enhance performance and engagement in the learning process (Fazriansyah, 2023; Fazriansyah, Sirri, & Faturohman, 2025; Sajirun et al., 2022; Sobandi & Nurlatifah, 2019). On the other hand, external factors such as lecturer competence, teaching variation, internet connectivity, and learning environment also play vital roles in shaping students' academic performance (Hamilton, 2019). These factors may either support or hinder learning outcomes depending on their effectiveness and accessibility.

Several aspects, however, remain underexplored or insufficiently examined. Previous studies have specifically investigated the factors influencing students' learning outcomes within the context of the Society 5.0 era. This era is marked by the integration of advanced technologies, rapid social transformation, and paradigm shifts in education (Destari, 2023; Siti Umi Khoiriah, Lia Karunia Lam Uli Lubis, & Diva Kayla Nazwa Anas, 2023). Students hold a central role in navigating education in the Society 5.0 era, as they are expected to develop critical thinking, creativity, and innovative abilities amid a society increasingly dominated by digital technologies (Damayanti, Arsanti, & Hasanudin, 2023). By exploring more deeply the factors influencing students' learning outcomes in the context of Society 5.0,

valuable insights can be provided for educators, researchers, and education practitioners in designing effective and adaptive learning strategies that align with contemporary demands. Consequently, there is a pressing need for newer and more relevant research to examine how these factors interact and influence students' learning outcomes in the digital era.

Furthermore, several existing studies have been limited to employing a single analytical method in examining the factors influencing learning outcomes. To gain a more comprehensive understanding, researchers should employ a mixed-methods approach using a sequential explanatory design. Through this approach, researchers can achieve a deeper understanding of the factors affecting students' learning outcomes in the Society 5.0 era by sequentially integrating quantitative and qualitative analyses. This allows for richer, more contextual insights that can guide better decision-making and the design of more effective educational interventions.

Based on the aforementioned background, the objectives of this study are to determine the influence of learning motivation, self-regulated learning, self-management, digital learning quality, environmental support, technological facilities, and lecturer competence in the Society 5.0 era on students' learning outcomes, and to further examine how technological advancements, rapid social changes, and emerging educational trends in the Society 5.0 era affect the factors that shape students' academic performance in this digital age.

2. METHODS

This study employed a mixed-methods approach using a sequential explanatory design, which integrates quantitative and qualitative analyses within a single research framework. In this design, the quantitative phase is conducted first, followed by the qualitative phase to strengthen, expand, and deepen the findings, as well as to uncover potential new insights (Wipulanusat, Panuwatwanich, Stewart, & Sunkpho, 2020).

The quantitative phase involved 240 participants, comprising students from mathematics education programs located in both the City and Regency of Tasikmalaya. The sample size was determined using the Slovin formula with a margin of error (e) of 5%. For the qualitative phase, participants were selected through a snowball sampling technique, involving 30 students who provided more in-depth perspectives to complement the quantitative results.

The research instrument consisted of a structured questionnaire designed to measure three main constructs: internal factors, external factors, and the influence of the Society 5.0 era on students' learning outcomes. Internal factors included indicators of learning motivation, self-regulated learning, and self-management. External factors covered digital learning quality, technological facilities, environmental support, and lecturer competence. The Society 5.0 construct measured students' perceptions of technological development, social change, and educational trends in the digital era.

Data analysis in this study was conducted through complementary quantitative and qualitative approaches. The quantitative data were analyzed using the Structural Equation Modeling–Partial Least Squares (SEM-PLS) method with the assistance of SmartPLS 4 software. This method was selected for its capability to examine complex relationships among latent variables, test the validity and reliability of measurement instruments, and its suitability for studies with a moderate sample size.

Table 1. SEM-PLS Analysis

Evaluation Model	Unit of Analysis	Criteria
Outer Model	Outer Loading	> 0.70
	Composite reliability	> 0.70
	Cronbach's alpha	> 0.70
	Average Variance Extracted (AVE)	> 0.50

	<i>Fornell-Larcker criterion</i>	<i>AVE of the laten constructs should be higher than any other latent construct</i>
<i>Inner Model</i>	<i>P-value</i>	< 0.05
	<i>R²-value</i>	0.75; 0.50; 0.25 (Substantial, Moderate, Weak)
	<i>Q²-value</i>	> 0

Source: (Hair, 2009, 2014; Hair Jr, Hair Jr, Sarstedt, Ringle, & Gudergan, 2023)

Meanwhile, the qualitative analysis was conducted using data obtained from semi-structured interviews, analyzed through a thematic analysis approach. The process involved transcribing the interview data, reducing and organizing the information, coding relevant segments, grouping them into categories, emerging themes, and drawing conclusions in the form of descriptive narratives. Subsequently, the results of both the quantitative and qualitative analyses were integrated through data triangulation. This integration aimed to strengthen the overall research findings, confirm the consistency between quantitative and qualitative results, and provide a more comprehensive understanding of the factors influencing the learning outcomes of mathematics education students.

3. FINDINGS AND DISCUSSION

Finding

The results of the quantitative analysis using Structural Equation Modelling-Partial Least Squares (SEM-PLS) are presented in two main stages, namely the outer model and the inner model assessments. In the outer model stage, the analysis was conducted to ensure that the indicators employed in this study were both valid and reliable in measuring their respective latent variables.

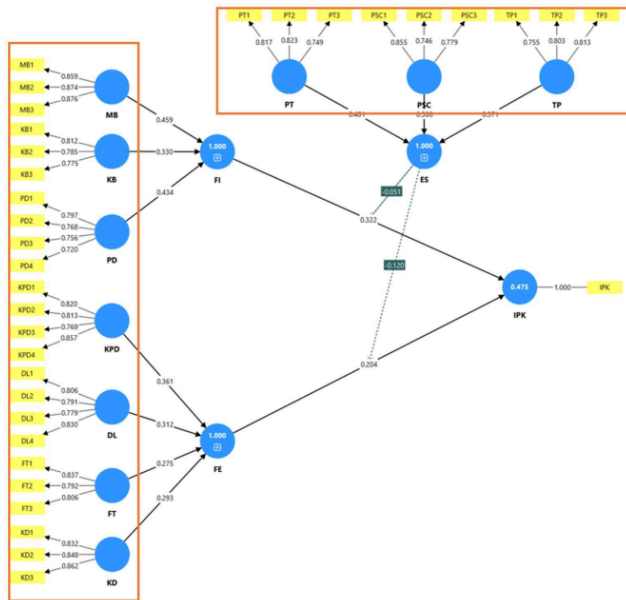


Figure 1. Outer Loading First-Order

As illustrated in Figure 1, all first-order indicators demonstrate loading factor values exceeding 0.70, indicating that each indicator is valid in measuring its respective dimension. In addition representing the item validity of each indicator, the loading factor values also reflect the magnitude of each indicator's contribution to its corresponding construct.

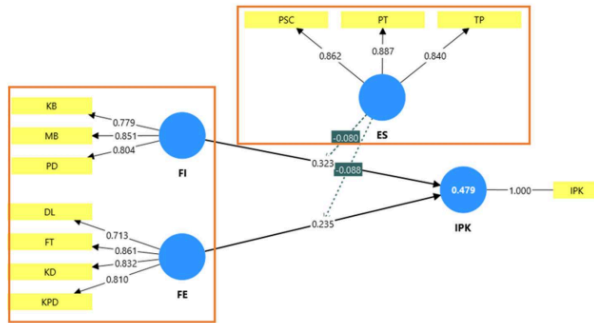


Figure 2. Outer Loading Second-Order

As shown in Figure 2, all dimensions of the second-order construct exhibit loading factor values greater than 0.70, indicating that all three dimensions are valid components forming the second-order construct. Values exceeding 0.70 signify a strong and consistent contribution of each dimension. The results that meet these criteria demonstrate that the second-order construct is well represented by its underlying dimensions, thereby confirming that the research model is valid and appropriate for measuring more abstract and complex concepts.

Table 2. Results of Reliability and Convergent Validity

	Code	Cronbach's alpha	Composite reliability	AVE
<i>First-Order</i>				
Learning Motivation	MB	0.839	0.903	0.756
Self-Regulated Learning	KB	0.701	0.833	0.625
Self-Management	PD	0.757	0.846	0.579
Quality of Digital Learning	KPD	0.832	0.888	0.665
Environmental Support	DL	0.815	0.878	0.643
Technological Facilities	FT	0.742	0.853	0.659
Lecturer Competence	KD	0.805	0.884	0.718
Technological Development	PT	0.711	0.839	0.635
Rapid Social Change	PSC	0.707	0.837	0.632
Educational Trends	TP	0.703	0.833	0.625
<i>Second-Order</i>				
Internal Factors	FI	0.743	0.853	0.659
External Factors	FE	0.819	0.881	0.650
Society 5.0 Era	ES	0.829	0.898	0.745

Source: Output SmartPLS 4

As presented in Table 2, all Average Variance Extracted (AVE) values are greater than 0.50, indicating that convergent validity has been satisfactorily achieved. Furthermore, the Composite Reliability (CR) and Cronbach's Alpha (CA) values exceed 0.70, demonstrating a high level of internal consistency among the measured constructs.

Table 3. Fornell-Larcker Criterion

First-Order											
	MB	KB	PD	KPD	DL	FT	KD	PT	PSC	TP	IPK
MB	0.870										
KB	0.453	0.791									
PD	0.551	0.470	0.761								
KPD	0.537	0.516	0.347	0.816							
DL	0.577	0.348	0.406	0.510	0.802						
FT	0.584	0.293	0.371	0.559	0.502	0.812					
KD	0.540	0.353	0.304	0.579	0.379	0.659	0.847				
PT	0.397	0.352	0.331	0.502	0.361	0.644	0.565	0.797			
PSC	0.480	0.358	0.378	0.443	0.384	0.569	0.562	0.667	0.795		
TP	0.510	0.385	0.374	0.463	0.526	0.572	0.528	0.633	0.552	0.791	
IPK	0.568	0.475	0.427	0.443	0.413	0.535	0.527	0.440	0.462	0.439	1.000

Second-Order				
	FI	FE	ES	IPK
FI	0.812			
FE	0.667	0.806		
ES	0.571	0.740	0.863	
IPK	0.610	0.600	0.518	1.000

Source: Output SmartPLS 4

The discriminant validity test using the Fornell-Larcker criterion presented in Table 3 shows that the square root of the Average Variance Extracted (AVE) for each construct is greater than the correlations among the constructs. This finding indicates that each latent variable is well distinguished from the others. Therefore, it can be concluded that the research instrument demonstrates good convergent validity, discriminant validity, and reliability, and is thus appropriate for proceeding to the inner model evaluation stage.

The evaluation of the inner model was carried out by analyzing the path relationships among latent constructs through the coefficient of determination (R^2), which reflects the extent to which the variance of the endogenous variables can be explained by the exogenous variables (Hair, 2014).

Table 4. Coefficient of Determination

	R Square Adjusted
IPK	0.465

Source: Output SmartPLS 4

As presented in Table 4, the Adjusted R Square value for Learning Outcomes (IPK) is 0.465, indicating that 46.5% of the variance in learning outcomes can be explained by internal and external factors, which reflects a moderate effect size.

To further assess the predictive relevance of the model, the Q^2 value was examined. According to Chin (1998) and Hair (2009), a Q^2 value greater than zero signifies that the model possesses good predictive capability, indicating that the observed data are well represented by the proposed structural model.

Table 5. Q Square Value

	Q Square
IPK	0.424

Source: Output SmartPLS 4

Table 5 shows that the Q^2 value exceeds the minimum threshold of 0, indicating a strong predictive relevance with a predictive capability for learning outcomes of 0.424. Thus, it can be concluded that this study demonstrates good observational quality.

The statistical significance of the relationships among latent constructs is determined by a P-value less than 5%, while the magnitude of the influence between latent constructs is assessed using the Path Coefficient (Hair, 2014).

Table 6. Path Analysis

	Path Coefficient	P-Values	Decision
<i>First-Order</i>			
MB→FI	0.459	0.000	Significant
KB→FI	0.330	0.000	Significant
PD→FI	0.434	0.000	Significant
KPD→FE	0.361	0.000	Significant
DL→FE	0.312	0.000	Significant
FT→FE	0.275	0.000	Significant
KD→FE	0.293	0.000	Significant
PT→ES	0.401	0.000	Significant
PSC→ES	0.386	0.000	Significant
TP→ES	0.371	0.000	Significant
<i>Second-Order</i>			
FI→IPK	0.323	0.000	Significant
FE→IPK	0.235	0.003	Significant
ES→IPK	0.158	0.046	Significant
FI x ES→IPK	-0.080	0.376	Not Significant
FE x ES→IPK	-0.088	0.278	Not Significant

Source: Output SmartPLS 4

The results presented in Table 6 indicate that all first-order constructs significantly influence their respective higher-order dimensions. Specifically, Learning Motivation (MB), Self-Regulated Learning (KB), and Self-Management (PD) were found to have a significant effect on the Internal Factors (FI) construct, with a p-value of $0.000 < 0.05$. This result confirms that students' intrinsic motivation, self-management, and self-regulation represent essential internal components that directly support learning achievement. Among these, learning motivation exhibited the highest contribution value (0.459), implying that motivated students are more likely to engage actively and persistently in the learning process, thereby achieving better academic outcomes.

Similarly, the External Factors (FE) construct was significantly influenced by the Quality of Digital Learning (KPD), Environmental Support (DL), Technological Facilities (FT), and Lecturer Competence (KD), each with a p-value of $0.000 < 0.05$. This finding demonstrates that the learning environment plays a substantial role in determining students' academic performance. The dimension with the greatest effect was the quality of digital learning (0.361), followed by environmental support and lecturer competence. This result reflects that digital learning systems supported by appropriate infrastructure and guided by competent lecturers enhance student engagement and facilitate better comprehension of learning materials.

In the context of the Society 5.0 Era (ES) construct, the dimensions of Technological Advancement (PT), Rapid Social Change (PSC), and Educational Trends (TP) also showed significant effects, with p-values of $0.000 < 0.05$. The dimension of technological advancement emerged as the most dominant (0.401), suggesting that students recognize technological innovation as the key driver of learning transformation in the Society 5.0 era. These results align with the notion that rapid technological progress, combined with evolving educational paradigms, shapes how students access, process, and apply knowledge in modern learning settings.

The second-order analysis further revealed that Internal Factors (FI) significantly influence Learning Outcomes (IPK) with a p-value of $0.000 < 0.05$. Likewise, External Factors (FE) also had a significant effect (p-value = $0.003 < 0.05$), while the Society 5.0 Era (ES) construct exhibited a smaller yet

still significant influence ($p\text{-value} = 0.046 < 0.05$). These results demonstrate that both internal and external factors contribute to students' academic success, with internal factors exerting the strongest overall influence.

However, the moderating effect of the Society 5.0 Era was found to be insignificant. The moderation between Internal Factors (FI) and the Society 5.0 Era (ES) resulted in a $p\text{-value}$ of $0.376 > 0.05$, and the moderation between External Factors (FE) and the Society 5.0 Era (ES) produced a $p\text{-value}$ of $0.278 > 0.05$. This implies that although the Society 5.0 context directly influences learning, it does not amplify or reduce the effects of internal or external factors on academic performance.

Qualitative findings obtained through interviews corroborate these quantitative results. Students consistently emphasized that motivation, self-regulated learning, and self-management are the key elements determining their learning outcomes. They explained that maintaining self-discipline and intrinsic motivation is essential in managing distractions especially those arising from digital platforms. Furthermore, students recognized the importance of external factors such as competent lecturers, interactive digital platforms, and sufficient technological facilities in creating an engaging and effective learning environment.

The interviews also revealed other influential elements not directly measured in the quantitative model, including health, psychological condition, self-confidence, and economic status. Students reported that poor health, stress, or limited financial resources often hindered their concentration and participation in online learning. Conversely, self-confidence and emotional stability were seen as catalysts for improved academic performance.

Discussion

The findings of this study provide comprehensive evidence that internal factors play the most dominant role in influencing students' learning outcomes. High levels of learning motivation, self-regulated learning, and self-management enable students to maintain focus, regulate learning behavior, and persist in achieving academic goals. These findings reinforce the perspectives of Abah et al., (2022) and Rachmawati et al., (2024), who argue that intrinsic motivation and self-regulation are essential psychological foundations for academic success, particularly in mathematics learning contexts. Students with stronger internal control mechanisms are more capable of adapting to challenges and maintaining academic consistency despite external pressures.

The influence of external factors especially the quality of digital learning and lecturer competence also proved significant. In the digital learning environment, the integration of multimedia tools, interactive platforms, and effective communication between lecturers and students enhances both engagement and comprehension. This result aligns with Zhang (2024), who emphasized that the quality of digital learning environments and adequate institutional support are vital in improving student engagement and learning satisfaction. Well-prepared lecturers who can effectively utilize technology also serve as role models for digital literacy and academic professionalism in the Society 5.0 context.

In the Society 5.0 Era, technological progress and rapid social changes redefine the educational landscape. The finding that technological advancement has the strongest influence within this construct is consistent with Fukuyama (2018), who described Society 5.0 as an era that harmonizes technological innovation with human well-being. However, the absence of a moderating effect indicates that technological and societal transformations function more as contextual backgrounds rather than as factors that enhance the direct relationship between internal and external variables and learning outcomes. Students perceive technological progress as a tool that facilitates learning, not as a determinant of their academic success.

The qualitative findings further enrich this understanding by illustrating students' lived experiences. They emphasize that learning outcomes depend primarily on internal readiness motivation, discipline, and independence supported by conducive external conditions such as digital

infrastructure and lecturer competence. This resonates with the principles of self-determined learning (heutagogy), where students assume active control over their educational processes, guided by supportive learning environments.

Beyond the main constructs, the emergence of health, psychological, self-confidence, and economic aspects in the qualitative data highlights that learning outcomes cannot be viewed solely through an academic lens. Physical health and psychological well-being, as found by Maghfiroh et al., (2023) and Sidik et al., (2024), are strongly correlated with students' ability to focus, manage stress, and sustain motivation. Moreover, self-confidence, as discussed by Ismiasih and Mustika (2024), is a critical affective trait that shapes how students face challenges, while economic constraints, as identified by Chen (2024), influence access to learning resources and technology both essential in digital education.

Therefore, the findings of this study underscore the need for a holistic approach to understanding academic achievement in the Society 5.0 era. Internal and external academic factors form the structural foundation of learning success, while personal and socio-economic conditions act as contextual variables that shape students' capacity to perform.

In conclusion, this study demonstrates that internal factors function as the core drivers of academic achievement, external factors serve as supportive reinforcers, and the Society 5.0 context provides a dynamic environment that introduces both opportunities and challenges for learners. The integration of quantitative and qualitative data not only validates the empirical relationships among constructs but also captures the depth of students' experiences, offering a more comprehensive perspective on how they adapt and succeed amid the digital transformation of education.

4. CONCLUSION

This study concludes that internal factors particularly learning motivation, self-regulated learning, and self-management play the most dominant role in determining students' learning outcomes in mathematics education. These internal factors serve as the foundation of academic success, as they directly influence students' engagement, persistence, and ability to manage learning challenges. External factors, including the quality of digital learning, technological facilities, environmental support, and lecturer competence, also contribute significantly by providing the necessary learning environment and technological infrastructure that reinforce students' internal capacities. The analysis further reveals that the Society 5.0 era has a direct influence on learning outcomes through technological advancement and social transformation, but it does not moderate the relationships between internal and external factors with learning outcomes. This finding suggests that while the context of Society 5.0 offers opportunities for innovation and digital learning, students' achievements remain primarily shaped by their motivation, self-management, and self-regulated learning, supported by a conducive and technology-enhanced learning ecosystem.

The integration of quantitative and qualitative findings provides a comprehensive understanding of how internal, external, and contextual factors interact in shaping academic performance. The qualitative data confirm that students perceive motivation, independence, and quality digital instruction as key determinants of success, while other elements such as health, psychological condition, self-confidence, and economic status also indirectly influence learning outcomes. These insights underscore the need for a holistic approach to education that not only strengthens cognitive aspects but also addresses emotional and socio-economic well-being.

This study is limited by its cross-sectional design, which restricts causal interpretation. Future research should adopt longitudinal or experimental approaches to examine long-term effects. The qualitative data were also limited to a small group of students, suggesting that broader and more diverse samples could provide deeper insights. Furthermore, future studies may expand the Society

5.0 construct to include aspects such as digital ethics, AI literacy, and social innovation. Comparative studies across disciplines and cultural contexts are also recommended to enhance generalizability.

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