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Academic performance in the digital era: The role of leadership style transformation and self-directed learning

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ABSTRACT

The aim of this study is to analyze how leadership styles and self-directed learning affect academic performance in the digital era. A quantitative correlational design was applied, with data collected from 301 final-year students at Universitas Muhammadiyah Makassar through a Likert-scale questionnaire and analyzed using Structural Equation Modeling (SEM) with AMOS. The results indicate that self-directed learning has the strongest positive influence on academic achievement, while transformational leadership also shows a significant effect by creating an inspiring learning environment. Task-oriented leadership contributes positively but to a lesser extent, whereas relationship-oriented leadership has a slight negative impact, suggesting the need for adjustments in highly competitive academic contexts. The study highlights the central role of self-directed learning, supported by transformational leadership, in improving academic performance and recommends that universities enhance leadership training and provide stronger support for independent learning through digital resources and personal development initiatives.

1. Introduction

Academic performance is one of the key indicators of individual success in the educational context (Alyahyan and Düştegör, 2020). It not only affects students' personal development but also contributes to the reputation of educational institutions (Al Hassani and Wilkins, 2022). Strong academic performance enhances education quality, aligning with SDG Goal 4, which emphasizes the importance of quality education for all (Polymeropoulou and Lazaridou, 2022). Thus, academic performance is not merely an individual responsibility but also a collective effort in achieving global educational objectives. Statistics indicate that countries with robust education systems tend to have higher participation rates in the global economy. A one-point increase in PISA scores contributes to a 0.5% long-term economic growth (Goczek et al., 2021). Therefore, educational institutions must focus on enhancing academic performance through various approaches, including effective leadership styles and fostering self-directed learning among students. In higher education, academic performance is closely linked to job opportunities and career development. Students with high academic performance have better employment prospects post-graduation, demonstrating that academic achievement is not just about grades but an investment in the future.

Good academic performance also contributes to students' social and emotional skill development (Hachem et al., 2022). High-achieving students tend to have stronger interpersonal skills, which are crucial in increasingly collaborative work environments (Soubra et al., 2022). Hence, academic performance has broad and diverse impacts, benefiting both individuals and society. Understanding the factors that influence academic performance, including leadership styles and self-directed learning, is therefore essential. This study aims to identify the relationship between relationship-oriented, task-oriented, and

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transformational leadership styles, self-directed learning, and academic performance.

Leadership style plays a crucial role in creating a supportive learning environment (Maqbool et al., 2023). This study examines three leadership styles: relationship-oriented, task-oriented, and transformational leadership. Relationship-Oriented Leadership emphasizes the importance of interpersonal relationships between leaders and team members. Leaders with this style focus on the emotional and social needs of their members, fostering a positive learning climate.

Task-Oriented Leadership focuses on goal achievement and measurable results. Leaders using this style set clear objectives and encourage their team to accomplish them. According to Muchanje and Wanyoko (2021), task-oriented leadership can improve efficiency and productivity in academic settings, though it may sometimes overlook the emotional aspects of interpersonal relationships. Transformational Leadership emphasizes innovation and positive changes. Transformational leaders inspire and motivate their members to reach their full potential.

Previous studies also indicate that effective leadership positively impacts students' academic performance. For example, research by Ertem (2021) found that students under transformational leadership demonstrated better academic performance than those under more authoritarian leadership styles. Therefore, a deeper understanding of these leadership styles is crucial for improving academic performance in educational institutions. Moreover, leadership styles do not operate in isolation. A combination of these three leadership styles yields a greater impact on students' academic performance. Thus, this study will explore the relationship between these leadership styles and self-directed learning within a broader academic context.

Self-directed learning is the ability of individuals to regulate and control their own learning processes (Loeng, 2020). In today's digital era, self-directed learning has become increasingly relevant, as students have greater access to learning resources and supporting technologies. Self-directed learning enhances student motivation and engagement, which in turn positively affects academic performance. Modern educational trends indicate that technology-based learning facilitates self-directed learning (Liwanag and Galicia, 2023). Platforms such as Coursera and Khan Academy allow students to learn at their own pace and according to their preferred learning styles.

Self-directed learning also cultivates critical and analytical skills (Hutasuhut et al., 2021). According to Sun et al. (2023), students engaged in self-directed learning are more likely to think critically and solve problems effectively, which is essential in academic settings. These skills are beneficial not only in education but also in increasingly complex professional environments. However, despite its benefits, not all students excel in self-directed learning. Research by Schunk and Zimmerman (2012) suggested that factors such as social support, intrinsic motivation, and leadership styles influence students' ability to learn independently. Understanding how leadership styles can either support or hinder students' self-directed learning is thus crucial.

This study will explore how different leadership styles affect students' self-directed learning and, ultimately, their academic performance. While many studies have examined the impact of leadership styles on academic performance, most focus on a single leadership style without considering the interaction between multiple leadership styles. This creates a gap in our understanding of how a combination of leadership styles influences students' academic performance. Research by Pizzolitto et al. (2023) suggested that a holistic approach considering various leadership styles provides a more comprehensive insight into the factors affecting academic performance. Furthermore, existing studies often overlook the role of self-directed learning within the context of leadership styles. Research by Xu et al. (2023) suggested that self-directed learning can mediate the relationship between leadership styles and academic performance, yet few studies have directly tested this connection. Hence, there is a need to explore how self-directed learning interacts with different leadership styles in an academic context.

Another gap to consider is the lack of research integrating contextual factors, such as culture and learning environments, in analyzing the relationship between leadership styles and academic performance. Liu et al. (2021) found that cultural context influences the effectiveness of certain leadership styles, but more in-depth research is needed to understand these complex dynamics. Most existing studies also employ limited methodologies, such as cross-sectional surveys, which fail to capture the dynamic changes in the relationship between leadership styles, self-directed learning, and academic performance over time. More in-depth longitudinal studies are required to provide a more accurate picture of these relationships.

This study aims to bridge these gaps by holistically exploring the relationship between leadership styles, self-directed learning, and academic performance. By doing so, it is expected to contribute significantly to existing literature and provide practical insights for educational policy development. Understanding the relationship between relationship-oriented, task-oriented, and transformational leadership styles and self-directed learning in an academic context is essential for improving student academic performance. This study will not only provide theoretical insights but also practical contributions to education policy and leadership training. Research by Özdemir et al. (2024) suggested that educational leaders who understand their leadership styles and their effects on students can create more effective learning environments.

The findings of this study are expected to offer recommendations for educational leaders in designing more effective leadership strategies. By understanding how leadership styles influence self-directed learning and academic performance, leaders can implement practices that holistically support student development. Moreover, this study has the potential to contribute to the development of better leadership training programs. Understanding the factors influencing academic performance enables training programs to equip educational leaders with the necessary skills to support students' independent learning and academic success. By integrating leadership styles, self-directed learning, and academic performance, this research aims to provide valuable insights for both theory and practice in education.

2. Research methodology

This study employs a quantitative approach with a correlational design. The purpose is to analyze relationships between leadership styles, including relationship-oriented, task-oriented, and transformational leadership, independent learning, and academic performance. This approach is suitable for identifying influences among variables. However, future research could enhance findings by triangulating quantitative data with qualitative approaches, such as interviews or focus groups.

The population of this study consists of final-year students at Universitas Muhammadiyah Makassar who are actively engaged in academic activities. The sample is selected using proportional random sampling, with a total of 301 respondents. This sample size is determined based on the minimum requirement for analysis using Structural Equation Modeling (SEM) in AMOS, which is 5–10 times the number of model parameters. The inclusion criteria include students who have completed more than four semesters and are willing to participate by signing an informed consent form.

This study examines the following variables: The independent variables (X) are relationship-oriented leadership (X1), task-oriented leadership (X2), and transformational leadership (X3). The dependent variable (Y) is academic performance, while the moderating variable (Z) is independent learning.

The research instrument consists of a questionnaire using a 5-point Likert scale to measure all variables (Table 1). Each variable is assessed using instruments developed based on previous theories and studies, including (1) relationship-oriented leadership; (2) task-oriented leadership: a task-based scale following the established model; (3) transformational leadership: indicators derived from Bass and Avolio's theory; (4) independent learning: a scale covering learning initiative, time management, and problem-solving; (5) academic performance: measured by semester grade point average (GPA) or cumulative GPA (CGPA); (6) the validity and reliability of the instruments are tested using Confirmatory Factor Analysis (CFA) in AMOS to ensure measurement accuracy and consist.

The data collection process consists of the following steps: (1) questionnaires are distributed either online or directly to the selected respondents; (2) respondents are given a specific period of time to complete the questionnaire; and (3) the collected data are checked to ensure completeness and accuracy. Data analysis is carried out using AMOS for both the measurement and structural models. The steps include: (1) a normality test, in which data distribution is examined using skewness and kurtosis values; and (2) validity and reliability tests, where CFA is applied to assess construct validity and instrument reliability.

Furthermore, the collected data is then analyzed using SEM analysis. This analysis is carried out to obtain a description related to:

a) Measurement Model: The measurement model examines the relationships between constructs and their respective indicators to ensure validity and reliability.
b) Structural Model: The structural model tests the relationships between independent, moderating, and dependent variables (Table 2). Goodness-of-Fit (GoF) Evaluation: The model's fit is assessed based on the following criteria: (1) Chi-Square (χ^2)/df: < 3.0; (2) Root Mean Square Error of Approximation (RMSEA): ≤ 0.08; (3) Comparative Fit Index (CFI), Goodness-of-Fit Index (GFI), Tucker-Lewis Index (TLI): ≥ 0.90.

Data analysis was conducted using SPSS for initial data processing and AMOS for Structural Equation Modeling (SEM) analysis. The selection of these software tools ensures the accuracy of the analysis and compatibility with the research methodology employed.

3. Results and discussion

The study identifies relationships between variables by measuring correlations and interpreting their strengths. The following presents the results of the analysis using AMOS, which are described in Fig. 1. From the results of the analysis in Fig. 1, the correlation of the variables studied can be described in Table 3.

The analysis results indicate that most relationships between variables fall within strong to very strong correlations, with transformational leadership and independent learning showing the most significant connection. These findings reinforce the importance of integrating leadership styles to support independent learning and overall academic performance

Self-directed learning is an intrinsic factor that drives individuals to take responsibility for their own learning process. In the digital era, easy access to various learning resources provides individuals with the flexibility to manage their time, methods, and learning objectives according to their needs.

This aligns with Knowles' (1984) theory of andragogy, which emphasizes that self-directed learning enables adult learners to become independent and active, enhancing their ability to manage their own learning. The stability and independence of self-directed learning, as demonstrated by a direct effect of 1.049, underscore the strong influence of this variable on academic performance due to the individual's direct involvement in achieving learning outcomes.

Table 1: The result of construct validity and reliability of the instrument

Variable	Indicator	Correlation (r)			Variances
		R	Sig	Status	
Relationship-oriented leadership (X_1)	$X_{1.1}$	0.695	0.000	Valid	1.058
	$X_{1.2}$	0.784	0.000	Valid	0.803
	$X_{1.3}$	0.823	0.000	Valid	0.610
	$X_{1.4}$	0.801	0.000	Valid	0.649
	$X_{1.5}$	0.784	0.000	Valid	0.705
	$X_{1.6}$	0.845	0.000	Valid	0.529
	$X_{1.7}$	0.804	0.000	Valid	0.679
	$X_{1.8}$	0.685	0.000	Valid	1.029
	$X_{1.9}$	0.833	0.000	Valid	0.556
Task-oriented leadership (X_2)	$X_{2.1}$	0.792	0.000	Valid	0.681
	$X_{2.2}$	0.782	0.000	Valid	0.660
	$X_{2.3}$	0.812	0.000	Valid	0.575
	$X_{2.4}$	0.817	0.000	Valid	0.525
	$X_{2.5}$	0.805	0.000	Valid	0.545
	$X_{2.6}$	0.802	0.000	Valid	0.564
	$X_{2.7}$	0.782	0.000	Valid	0.608
	$X_{2.8}$	0.774	0.000	Valid	0.691
	$X_{2.9}$	0.770	0.000	Valid	0.680
Transformational leadership (X_3)	$X_{3.1}$	0.785	0.000	Valid	0.184
	$X_{3.2}$	0.800	0.000	Valid	0.182
	$X_{3.3}$	0.816	0.000	Valid	0.203
	$X_{3.4}$	0.781	0.000	Valid	0.243
	$X_{3.5}$	0.777	0.000	Valid	0.222
Academic performance (Y)	$Y_{1.1}$	0.830	0.000	Valid	0.159
	$Y_{1.2}$	0.860	0.000	Valid	0.142
	$Y_{1.3}$	0.819	0.000	Valid	0.179
	$Y_{1.4}$	0.804	0.000	Valid	0.178
	$Y_{1.5}$	0.555	0.000	Valid	0.483
Independent learning (Z)	$Z_{1.1}$	0.659	0.000	Valid	0.425
	$Z_{1.2}$	0.721	0.000	Valid	0.263
	$Z_{1.3}$	0.563	0.000	Valid	0.583
	$Z_{1.4}$	0.756	0.000	Valid	0.236
	$Z_{1.5}$	0.783	0.000	Valid	0.244
	$Z_{1.6}$	0.789	0.000	Valid	0.221
	$Z_{1.7}$	0.706	0.000	Valid	0.320
	$Z_{1.8}$	0.712	0.000	Valid	0.294

Table 2: The test of the relationship between independent, moderating, and dependent variables

Goodness of fit indices	Cut off value	Result	Interpretation
Chi-square (χ^2)	Not significant ($p > 0.05$)	$\chi^2 = 100.456$, $p = 0.112$	Statistically fit
GFI (goodness of fit index)	≥ 0.90	0.934	Excellent
AGFI (adjusted GFI)	≥ 0.90	0.910	Good
TLI (Tucker-Lewis index)	≥ 0.90 (marginal: 0.80–0.89)	0.951	Excellent
RMSEA (root mean square error of approximation)	≤ 0.08 (good: ≤ 0.05)	0.0042	Excellent

Table 3: The correlation of the variables

Relationship	Correlation	Interpretation (aligned with fit SEM model)
$X_1 \leftrightarrow X_2$ (relationship-oriented ↔ task-oriented leadership)	0.891	Very strong positive relationship. This indicates that relationship-oriented leadership and task-oriented leadership are conceptually and empirically aligned, supporting the model's internal consistency and contributing to its high GFI and TLI values.
$X_2 \leftrightarrow X_3$ (task-oriented ↔ transformational leadership)	0.847	Very strong correlation. The strong link between task execution and transformational qualities enhances model efficiency (TLI = 0.951) and explains the model's low RMSEA (0.042), showing minimal approximation error.
$X_1 \leftrightarrow X_3$ (relationship-oriented ↔ transformational leadership)	0.749	Strong correlation. The interpersonal qualities of relationship-oriented leadership contribute significantly to the emergence of transformational leadership, reinforcing structural validity (high AGFI = 0.910).
$X_3 \leftrightarrow Z$ (transformational leadership ↔ independent learning)	0.861	Very strong positive relationship. This link is central to the structural model, justifying the strong model fit indices (GFI, TLI). It explains how leadership vision and motivation foster independent learning.
$X_2 \leftrightarrow Z$ (task-oriented ↔ independent learning)	0.757	Strong correlation. Task structuring and clarity support learners' self-management, fitting well into the SEM framework and supporting a low RMSEA.
$X_1 \leftrightarrow Z$ (relationship-oriented ↔ independent learning)	0.659	A moderately strong correlation. While still significant, this path shows slightly less structural weight—consistent with its relatively lower correlation and reinforcing that the model differentiates between social-emotional and transformational influences on independent learning.

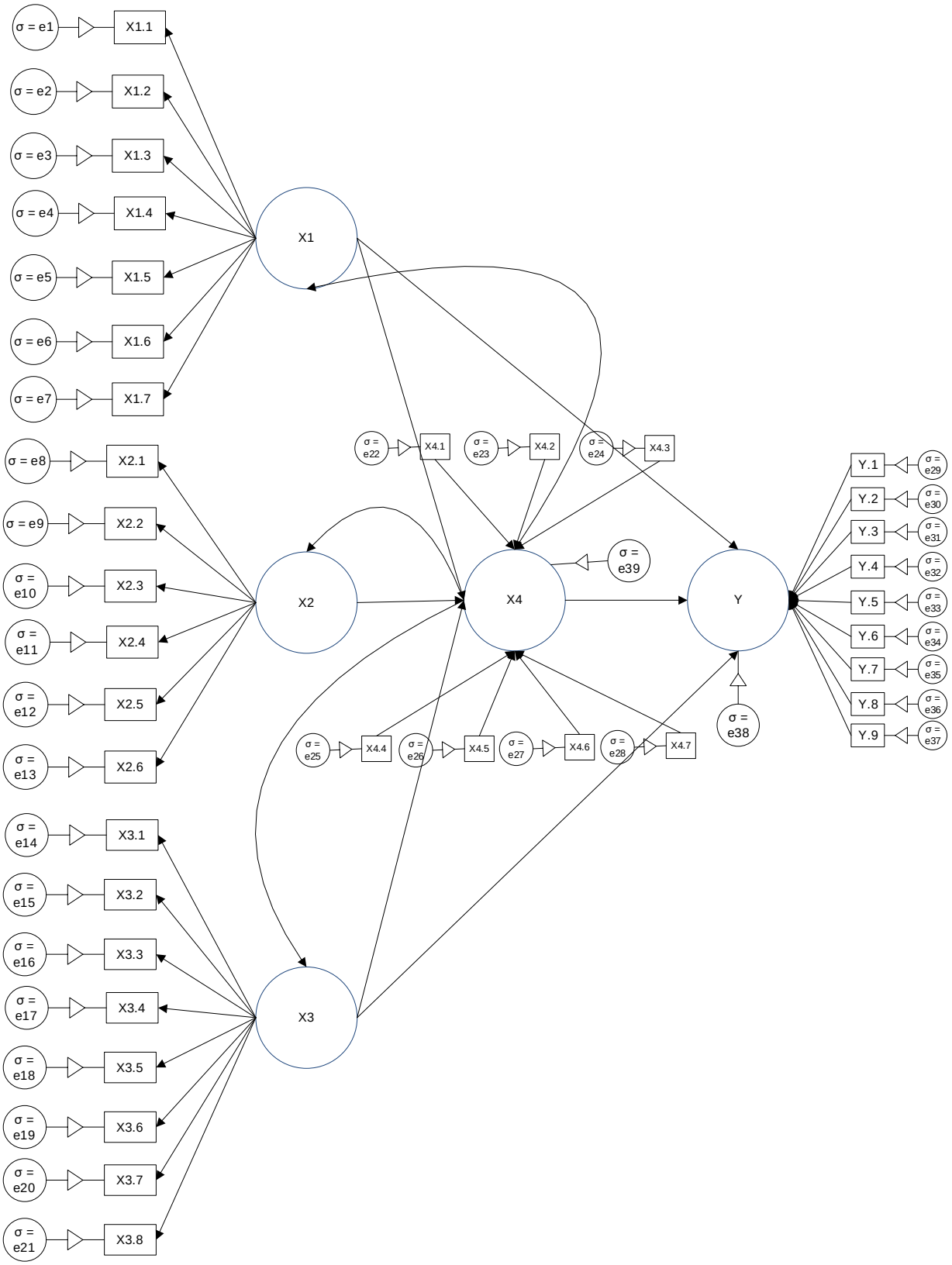

Fig. 1: The results of data analysis through AMOS

On the other hand, transformational leadership has a significant positive impact on academic performance, with a coefficient of 0.177. This is supported by the research of Al-Husseini et al. (2021), which found that transformational leadership is an approach that fosters innovation, vision, and inspiration, thereby enhancing individual performance effectiveness. By providing long-term goals and emotional reinforcement, transformational leadership creates a supportive learning environment. The high direct effect of this leadership style on itself reflects its consistency and positive impact on followers, including in academic settings.

Conversely, task-oriented leadership has a minimal positive influence on academic performance. Halliwell et al. (2022) emphasized that task-oriented leadership behavior focuses on achieving specific targets and efficiency. However,

this approach is often too mechanical, offering limited support for creativity and flexibility in learning. In academic contexts, while effective in achieving tangible outcomes such as curriculum completion or administrative tasks, this leadership style can have significant psychological effects, such as emotional exhaustion and stress (Shao et al., 2022). This limits opportunities for creativity and innovation, making the academic environment less adaptive to change (Acar et al., 2019). Similarly, relationship-oriented leadership shows a slight negative effect on academic performance (Henkel et al., 2019). Excessive focus on interpersonal harmony can often reduce pressure or motivation to achieve higher targets (De Clercq et al., 2022). Overly relationship-oriented leadership may decrease effectiveness in situations requiring concrete results (Scandura and Meuser, 2022). Although this leadership style exhibits stability, as reflected by its direct effect on itself, its approach needs adjustment to better support the demands of competitive academic environments.

The reinforcement of self-directed learning and transformational leadership has a strong direct effect on academic performance, as both promote independence, innovation, and transformation relevant to modern academic needs. Self-directed learning grants individuals the freedom to manage their learning methods, schedules, and goals according to their needs. Individuals are more motivated when they have control over their own learning (Luo et al., 2021). Meanwhile, transformational leadership fosters innovation and positive change by providing motivation and inspiration to followers. In an academic context, transformational leaders not only inspire followers to achieve targets but also motivate them to exceed expectations. With a clear long-term vision and strong emotional support, transformational leaders create an environment that encourages collaboration and positive transformation.

In dynamic academic environments, an overly technical or interpersonal approach is insufficient for optimal achievement. A combination of independence, supported by self-directed learning, and inspiration from transformational leadership is needed to create an adaptive, innovative, and supportive environment for maximizing individual potential. This adaptive and flexible approach ensures that academic environments evolve in response to modern demands without compromising well-being or productivity.

The relationship between relationship-oriented leadership (X_1) and task-oriented leadership (X_2) shows a very strong correlation. This can be explained by the fact that in both managerial and educational practices, these two leadership styles naturally complement each other. A leader who is capable of building strong interpersonal relationships typically does not overlook structural aspects and performance targets. In academic settings, leaders such as school principals or senior lecturers often adopt both styles simultaneously prioritizing relational well-being while still demanding administrative achievement. This combination is commonly found in educational institutions that are both hierarchical and humanistic in nature, making the very strong correlation between them justifiable.

A very strong correlation is also evident between task-oriented leadership (X_2) and transformational leadership (X_3). This reflects the idea that transformational leadership does not eliminate task elements; rather, it utilizes them as instruments to achieve long-term vision and change. Transformational leaders set concrete goals as part of their innovation and transformation strategies. In educational institutions undergoing transformation, such as during the digitalization of learning systems, leaders are expected to align clear task structures with a transformative mindset. Thus, this relationship is very strong because both leadership styles reinforce each other functionally.

Meanwhile, the relationship between relationship-oriented leadership (X_1) and transformational leadership (X_3) demonstrates a strong correlation. Although transformational leadership requires strong interpersonal skills, not all leaders who excel in interpersonal relationships can necessarily drive change or articulate a compelling long-term vision. In practice, leaders who prioritize interpersonal harmony tend to build trust and loyalty more easily, which can serve as a foundational platform for transformation. However, due to differences in long-term orientation and strategic vision, this correlation is not as strong as that between X_2 and X_3.

The very strong correlation between transformational leadership (X_3) and independent learning (Z) indicates a deep connection between leadership inspiration and learning autonomy. Transformational leaders create an environment that motivates learners and fosters their sense of responsibility for their own learning process. This aligns closely with the principles of self-directed learning, which require internal motivation, personal vision, and self-confidence. In the context of flexible, technology-based digital learning, the role of transformational leaders is crucial in guiding students to become autonomous learners.

The relationship between task-oriented leadership (X_2) and independent learning (Z) also shows a strong correlation. Although this leadership style is primarily structural and instructional, it can support self-directed learning in certain contexts. Clear instructions, measurable targets, and strict time management can help students develop self-discipline. However, since independent learning also demands flexibility and intrinsic motivation, a leadership approach that is overly mechanical may limit students' creativity and autonomy. Therefore, while the correlation is strong, its impact is not as comprehensive as that of transformational leadership.

Conversely, the relationship between relationship-oriented leadership (X_1) and

independent learning (Z) shows a moderately strong correlation. This leadership style fosters a psychologically safe and comfortable learning environment, which is indeed important. However, in practice, an overly interpersonal approach without sufficient challenge or performance drive may result in students lacking the motivation to engage in self-directed learning. While they may feel emotionally supported, they may not be sufficiently encouraged to take initiative or set their own learning goals.

Overall, the combination of task-oriented and transformational leadership provides the most solid foundation for supporting independent learning, as it integrates both structure and vision. Relationship-oriented leadership, meanwhile, plays a complementary role in creating a secure and comfortable environment, but it is less optimal when not accompanied by task guidance or transformational vision. Transformational leadership serves as the central connector bridging all three structures, relationship, and autonomy—thus driving more comprehensive academic performance.

Academic leadership plays a strategic role in determining the quality of classroom learning, especially in higher education, which demands innovation and adaptability in response to curriculum changes and student dynamics. One prominent approach to enhancing learning quality is the clinical supervision model, as described by Babo and Syamsuddin (2022). This model emphasizes the crucial role of academic leaders such as senior lecturers, course coordinators, or even deans in providing reflective guidance and systematic support to other lecturers. In classroom practice, lecturers who adopt clinical leadership actively engage in observing learning processes, offering data-based feedback, and collaboratively reflect on teaching strategies. This approach not only strengthens the professionalism of lecturers but also promotes more adaptive, evidence-based teaching that aligns with students' needs.

Furthermore, Syamsuddin et al. (2022) highlighted the importance of transformational leadership styles within higher education. The implementation of the Merdeka Belajar Kampus Merdeka (MBKM) curriculum demands that lecturers act not only as instructors but also as facilitators who empower students through collaborative and contextual approaches. In this context, lecturers are expected to possess a clear vision of learning, foster students' intrinsic motivation, and create an academic atmosphere that is both innovative and inclusive. Transformational leadership is reflected in the lecturer's ability to lead project-based learning, interdisciplinary collaboration, and reflective practices that empower students as active participants in the learning process.

Meanwhile, the emotional and relational aspects of a lecturer's leadership also play a significant role in classroom dynamics, as described by Ilyas et al. (2020). In cooperative-based learning environments, the success of interaction between lecturers and students heavily depends on the lecturer's emotional intelligence. Lecturers who can demonstrate empathy, build positive relationships, and manage their emotions effectively are more likely to create a conducive learning environment. Such relational leadership fosters social closeness, builds trust, and enhances students' active participation— especially critical factors in managing diverse and psychologically complex classrooms.

Complementing these perspectives, Agustan et al. (2017) illustrated how lecturer leadership that supports reflection and learning autonomy is vital for improving students' academic performance. In this context, lecturers act as leaders who not only deliver content but also guide students to think critically, evaluate their own cognitive processes, and develop metacognitive skills. Leadership that allows for idea exploration, open-ended questioning, and independent reflection creates a learning atmosphere that nurtures students' intellectual growth. This aligns with the demands of modern higher education, which emphasizes independent thinking and personal responsibility in the learning process.

Findings from this study confirm that transformational leadership and self-directed learning are the most influential factors in enhancing academic performance, especially in digital and dynamic educational settings. This result aligns well with previous literature that underscores the importance of inspirational, visionary leadership and learner autonomy in supporting educational outcomes.

Numerous studies reinforce these findings. Li and Liu (2022) showed that transformational leadership among school principals significantly improves teacher effectiveness through motivation and emotional support, reinforcing the model's assumption that transformational leadership fosters both innovation and inspiration. Similarly, Bastari et al. (2020) emphasized that transformational leadership positively influences performance via work motivation, while Andriani et al. (2018) demonstrated its positive effects on teacher performance.

The effectiveness of transformational leadership becomes more pronounced when integrated with psychological and organizational factors. Lai et al. (2020) confirmed that the combination of transformational leadership, work motivation, and job satisfaction contributes significantly to performance improvement. Furthermore, Shafait et al. (2021) highlighted the direct link between transformational leadership and the strengthening of self-directed learning, an essential alignment with the present study's findings. In broader institutional contexts, Liu et al. (2021) affirmed that transformational leadership, when supported by positive organizational culture and educational policies, leads to improved performance and commitment.

However, not all findings in the literature fully align with this study. For example, Botha and Aleme (2023) highlighted the role of relationship-oriented and task-oriented leadership in enhancing organizational commitment rather than academic performance. This divergence suggests that while traditional leadership approaches may contribute to institutional loyalty, they are less responsive to the innovation and flexibility demanded in the digital era. Similarly, Weber et al. (2022) emphasized the balance between task, relationship, and change-oriented leadership for organizational effectiveness, though their study did not focus on digital or academic settings. In contrast, Şahin and Bilir (2024) strongly supported this study's results by demonstrating how transformational leadership, innovation, and organizational learning enhance individual performance through intrinsic motivation and a sense of ownership. In summary, the evidence overwhelmingly supports the conclusion that transformational leadership and self-directed learning are more adaptive and effective for improving academic performance in dynamic learning environments. In contrast, relationship-oriented and task-oriented leadership styles, while still relevant, appear to play a more limited or indirect role in performance outcomes.

Despite these insights, this study recognizes several limitations. First, academic performance was examined through a single-dimensional lens, potentially oversimplifying a complex construct that includes both quantitative outcomes (e.g., GPA, test scores) and qualitative factors (e.g., skill development, creativity). Subjectivity in evaluating academic performance can also reduce the consistency of the findings. Therefore, future research should adopt a multidimensional framework, incorporating both cognitive and non-cognitive indicators such as collaboration, innovation, and leadership in academic projects.

To improve objectivity, standardized rubrics, portfolio assessments, and peer evaluations should be applied. Gathering feedback from multiple stakeholders (e.g., students, lecturers, external reviewers) can also enhance data validity. Additionally, longitudinal studies are recommended to capture the long-term effects of leadership and learning strategies. Future research should also explore moderating and mediating variables, such as learning motivation, emotional intelligence, or institutional support, to better understand the mechanisms underlying leadership effects.

The implications of these findings extend beyond education into the professional world. Self-directed learning enhances employee autonomy and adaptability skills critically in today's evolving job market. Meanwhile, transformational leadership fosters team innovation and productivity by encouraging vision, creativity, and motivation. Organizations can adopt multidimensional performance evaluations, which assess both output (quantitative) and contribution to innovation or personal growth (qualitative). This approach promotes a more holistic view of human performance.

Educational institutions can apply these insights by providing resources and training that strengthen self-directed learning, such as interactive e-learning, academic mentoring, and independent study programs. Furthermore, empowering educators with transformational leadership competencies through targeted training can foster a more motivating and innovative academic climate. While task-oriented leadership has a limited effect, its role in establishing structure and accountability remains essential. Thus, integrating it with emotionally intelligent approaches can improve its relevance. On the other hand, relationship-oriented leadership should be critically examined, ensuring it supports, rather than distracts from, academic goals.

In conclusion, a comprehensive and adaptive approach that blends self-directed learning, transformational leadership, and balanced task-relationship strategies is essential for sustaining academic success. This integrated framework will not only improve individual performance but also help institutions adapt effectively to the changing demands of education in the digital era.

4. Conclusions

Optimizing academic performance in the digital era can be achieved through the enhancement of self-directed learning and the transformation of leadership styles. Self-directed learning has been proven to have the most significant impact on academic performance, emphasizing the importance of initiative, independence, and the ability to manage one's learning process autonomously. Additionally, transformational leadership makes a substantial positive contribution by fostering inspiration, motivation, and the development of a shared vision, which creates a conducive and innovative learning environment. Although task-oriented leadership has a minor positive effect, it remains relevant in providing structure and clarity of responsibilities. However, relationship-oriented leadership exhibits a slight negative impact on academic performance, possibly due to an excessive focus on interpersonal harmony, which may divert attention from academic goal attainment. This study reaffirms that self-directed learning and transformational leadership are key elements in achieving optimal academic performance in the digital era. Therefore, educational institutions must adopt adaptive and innovative approaches, integrating self-directed learning with effective leadership to create an academic environment that meets the demands of the times.

List of abbreviations

AGFI	Adjusted goodness-of-fit index
AMOS	Analysis of moment structures (a software for SEM)
CFA	Confirmatory factor analysis

CFI	Comparative fit index
CGPA	Cumulative grade point average
df	Degrees of freedom
GFI	Goodness-of-fit index
GoF	Goodness-of-fit
GPA	Grade point average
MBKM	Merdeka Belajar Kampus Merdeka
PISA	Programme for International Student Assessment
RMSEA	Root mean square error of approximation
SDG	Sustainable Development Goal
SEM	Structural equation modeling
SPSS	Statistical package for the social sciences
TLI	Tucker–Lewis index
X_1	Relationship-oriented leadership
X_2	Task-oriented leadership
X_3	Transformational leadership
Y	Academic performance
Z	Independent learning
χ^2	Chi-square

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Compliance with ethical standards

Ethical considerations

All participants provided informed consent prior to participation, and their anonymity and confidentiality were guaranteed. Participation was voluntary, and respondents could withdraw at any stage without penalty.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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