



Mapping Generational Digital Literacy and Internet Usage Patterns in Open and Distance Learning: A K-Means Clustering Analysis

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Abstract: This study aims to map digital literacy and internet-use patterns among multigenerational new students in open and distance learning (ODL) and to determine whether the resulting profiles are differentiated solely by generation or also by occupational and behavioral characteristics. A quantitative exploratory design with K-Means cluster analysis was applied to data from 4,371 new students at Universitas Terbuka Jakarta. The analysis integrated generational profile, occupation, internet-access time, dominant online activity, preferred social-media platform, daily social-media duration, and digital-literacy classification. The Elbow Method indicated a five-cluster solution. The cluster represented 17.00%, 24.94%, 18.39%, 9.40%, and 30.27% of respondents, respectively. Overall, 62.18% of students were classified as High and 35.69% as Very High in digital literacy, while only 2.13% were Satisfactory and none were Low or Very Low. Cluster 3, dominated by Generation Y private employees, contained 97.01% Very High-literacy students, whereas Cluster 5, also dominated by Generation Y private employees, contained 98.49% High-literacy students. Generation Z appeared across three clusters with distinct access timed and online activities. These findings show that generation alone does not adequately explain digital-literacy patterns in ODL; occupational background and digital-use behavior provide additional differentiation. The results supports cluster-based digital-literacy support, flexible learner services, and targeted skill development in ODL.

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Introduction

With the growing interconnectedness of the 21st century, digital literacy has become essential in modern life. Those with solid digital literacy are more likely to use digital tools creatively, solve problems related to the digital age, and improve efficiency across different industries. Digital literacy entails selecting and utilizing digital technologies with appropriate planning and context (Ozdamar-Keskin et al., 2015) and contributes to personal and social development amid rapid advancements in communication and information technology (Wu, 2024). In open and distance learning settings, digital literacy is a crucial aspect of education, as students must access online resources, interact with digital content, communicate effectively in virtual spaces, and participate in group discussions (Kasımoğlu, Bahçelerli & Çelik, 2022; Maphosa & Bhebhe, 2019; Yu, 2022). Students are also expected to analyze online materials independently and use various technological tools to complete their academic work. In addition, the widespread use of digital technology requires students to use



technology critically, safely, and responsibly because of risks such as cybercrime, cyberbullying, fraud, and other harmful behaviors (Deora & Chudasama, 2021; Reddy et al., 2023). Through digital literacy, students can complete assignments, interact with instructors, and access various learning materials, enhancing education's interactive and practical nature (Fitriyani & Mukhlis, 2021). Digital literacy impacts students' teaching and learning processes, affecting their ability to manage classes and maximize their learning (Muntu et al., 2023). Additionally, it raises public recognition of digital security and fosters responsible behavior in online environments, preventing ethical breaches that could harm individual and organizational reputations (Rasidi, 2023). Therefore, digital literacy is particularly important for students who are expected to learn independently in technology-mediated educational environments.

Although digital literacy has received increasing attention in Indonesia, national indicators suggest that further improvement is still required. Indonesia has a digital literacy rate of just 62%, below the ASEAN average of 70% (Anam, 2023), while its digital competitiveness was ranked 51st out of 63 countries (Sinaga, 2023). The “Status Literasi Digital Indonesia tahun 2022” report categorized Indonesia’s digital literacy index as moderate, with an overall score of 3.54 across four pillars: digital skills, digital ethics, digital safety, and digital culture. In the education sector, the average digital literacy index was 3.7 (Agustini, 2023). These findings indicate that digital literacy is multidimensional and that competence may vary across different aspects of technology use.

Universitas Terbuka (UT) offers open and distance learning without age restrictions and serves a diverse, multigenerational student population (Kharis et al., 2024). This diversity provides an opportunity to investigate how digital literacy varies across students with different generational and background characteristics. Students from different generations may have different experiences with technology, but generational membership alone may not fully explain their digital competence. Occupational background, patterns of internet access, online activities, and social media use may also distinguish how students engage with digital technologies. This issue remains important in open and distance higher education (ODHE), where studies have more commonly examined overall digital literacy levels or individual demographic characteristics rather than how multiple students’ characteristics combine to form distinct digital profiles.

To examine this heterogeneity, this study applies K-Means clustering, an unsupervised machine-learning method that groups observations according to similarities in their characteristics (Kharis, 2021; Kim et al., 2020). K-Means was selected because it can efficiently partition a large dataset into relatively homogeneous groups by minimizing within-cluster variation (Amer, 2020; Ali et al., 2022). Unlike conventional statistical approaches that primarily compare predefined groups or examine relationships between individual variables, clustering allows student profiles to emerge from combinations of generational characteristics, occupational backgrounds, internet-use patterns, social media behavior, and digital literacy. This data-driven segmentation is therefore appropriate for identifying heterogeneous learner profiles within a diverse ODHE population.

Accordingly, this study aims to identify and characterize distinct profiles of new students at Universitas Terbuka Jakarta based on their digital literacy, generational characteristics, occupational backgrounds, and digital-use behaviors using K-Means clustering. The study contributes to the literature by moving beyond a simple Generation Z-Generation Y comparison and demonstrating how digital literacy profiles emerge from combinations of generational and background characteristics. Practically, the resulting clusters can provide an empirical basis for designing more targeted digital literacy

interventions, technological support, and learning strategies for heterogeneous students in open and distance higher education.

Research Method

This study used a quantitative exploratory design with cluster analysis. The research process consisted of five main stages: data collection, preprocessing, normalization, clustering, and data analysis, as illustrated in Figure 1. Primary data were obtained from 4,371 new students at Universitas Terbuka Jakarta through a structured questionnaire. The respondents were selected using a simple random sampling technique, whereby each member of the population had an equal chance of being selected as a sample.

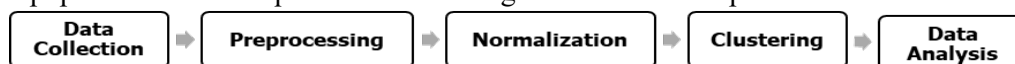


Figure 1. Research Steps

The questionnaire collected information on respondents' generational profiles, occupational backgrounds, internet access patterns, internet activities, social media use, and digital literacy. The digital literacy indicators were developed with reference to the National Digital Literacy Index established by Indonesia's Ministry of Communication and Information Technology, comprising four primary elements: digital skills, digital ethics, digital safety, and digital culture (Agung et al., 2022). Digital skills refer to the ability to recognize, understand, and use ICT hardware and software (Nisa et al., 2023); digital ethics concerns ethical conduct in digital interactions (Iriyani & Puji Lestari, 2023); digital safety relates to personal data protection and security in digital environments (Koesmaryanto Oetomo et al., 2023). Digital culture encompasses the capacity to comprehend, interpret, familiarize, and construct national insight in line with the values of Pancasila and Bhineka Tunggal Ika. Moreover, the digitization of culture through ICT contributes to digital citizenship and digital media culture within Indonesia's formal domain of citizenship (Riyanto & Abror, 2021).

The digital literacy instrument consisted of 33 Likert-scale items covering 12 digital skills items, 8 digital ethics items, 7 digital safety items, and 6 digital culture items. The instrument had previously undergone validity and reliability testing involving 4,347 new students at Universitas Terbuka Jakarta. Validity was examined using Pearson item-total correlation at a significance level of 1%, with a critical value of $r = 0.039$. All 33 items met the validity criteria. The Pearson correlation coefficients ranged from 0.670 to 0.812 for digital skills, 0.493 to 0.6999 for digital ethics, 0.503 to 0.884 for digital safety, and 0.642 to 0.815 for digital culture. Reliability was assessed using Cronbach's Alpha to evaluate the internal consistency of the questionnaire. The Cronbach's Alpha coefficients were 0.921 for digital skills, 0.710 for digital ethics, 0.826 for digital safety, and 0.854 for digital culture, indicating that all four dimensions demonstrated acceptable reliability. The average digital literacy score for each respondent was subsequently classified into five categories: very low, low, satisfactory, high, and very high, as presented in Table 1 (Podgorny & Volokhova, 2020).

Table 1. The Classification of the Digital Literacy Index

Value	Level	Descriptors
1-20	Very Low	Very limited digital literacy and ability to use digital resources.
21-40	Low	Limited knowledge and use of basic digital tools.
41-60	Satisfactory	Moderate digital literacy with basic information search and application skills.
61-80	High	Strong understanding and effective, secure use of digital technologies.
81-100	Very High	Advanced digital competence, adaptability, and ability to guide others.

After data collection, the dataset underwent preprocessing, including checking for missing values, duplicate records, and inconsistencies (Maharana, Mondal, & Nemade, 2022). The data were then normalized onto a common scale to ensure comparability across variables (Larriva-Novio et al., 2021). The clustering approach in this study was based on K-Means, which was selected because it can efficiently group similar data points into distinct clusters (Cebeci & Yildiz, 2015; Zeebaree et al., 2017). The algorithm iteratively assigns observations to the nearest cluster centroid and recalculates the centroids to minimize within-cluster variation. Clustering was performed using variables representing generational profiles, occupational backgrounds, internet access patterns, internet activities, social media use, and digital literacy. The optimal number of clusters (k) was determined using the Elbow Method. For each candidate value of k , the Sum of Squared Errors (SSE) was calculated based on the squared distance between each observation and the centroid of its assigned cluster. As the number of clusters increases, SSE generally decreases. The optimal number of clusters was identified at the point where the reduction in SSE began to diminish substantially, producing an “elbow” that balances within-cluster variation and model complexity.

Results and Discussion

The Elbow Method was used to determine the optimal number of clusters for the K-Means analysis. As shown in Figure 2, the SSE decreases substantially as the number of clusters increases. The reduction in SSE was 4,338.605 at $k = 2$, 3,047.535 at $k = 3$, 1,929.750 at $k = 4$, and 1,783.417 at $k = 5$. After $k = 5$, the reduction became more gradual, decreasing to 1,511.211 at $k = 6$, 1,135.738 at $k = 7$, and 950.360 at $k = 8$. This pattern indicates that the improvement in cluster compactness began to diminish around $k = 4 - 5$. Therefore, $k = 5$ was selected as a reasonable balance between reducing within-cluster variation and maintaining model simplicity.

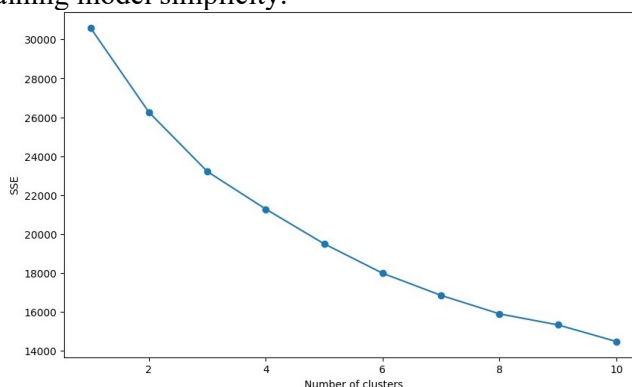


Figure 2. Elbow method for optimal k

The K-Means analysis $k = 5$ resulted in clusters containing 743, 1090, 804, 411, and 1323 students, respectively.

Table 3. Mode of Generational Profile, Occupational Profile, and Internet Access Hours of New Students

Cluster	Generational Profile	Occupational Profile	Internet Access Hours
1	13-22 years old (Generation Z)	Private Employee	06.01-12.00
2	13-22 years old (Generation Z)	Private Employee	18.01-24.00
3	23-38 years old (Generation Y)	Private Employee	18.01-24.00
4	13-22 years old (Generation Z)	Entrepreneur	18.01-24.00
5	23-38 years old (Generation Y)	Private Employee	18.01-24.00

Cluster characteristics were examined based on generational profile, occupational profile, internet access hours, internet activities, social media platforms, daily social media use, and digital literacy classification. Table 3 and 4 summarize the dominant characteristics of each cluster, while Tables 5-11 present their detailed percentage distributions.

Table 4. Mode of the Most Frequent Internet Activities, the Most Commonly Used Social Media Platforms, Daily Usage Duration, and Digital Literacy Classification

Cluster	The Most Frequent Internet Activities	Social Media Platforms	Daily Usage Duration	Digital Literacy Classification
1	Communicating via instant messaging (WhatsApp, Telegram, etc)	WhatsApp	3-5 hours	High
2	Using social media	Instagram	3-5 hours	High
3	Communicating via instant messaging (WhatsApp, Telegram, etc)	WhatsApp	3-5 hours	Very High
4	Communicating via instant messaging (WhatsApp, Telegram, etc)	WhatsApp	3-5 hours	High
5	Communicating via instant messaging (WhatsApp, Telegram, etc)	WhatsApp	3-5 hours	High

Table 5. Distribution of Generational Profiles per Cluster (%)

Cluster	Generation Z	Cluster	Generation Z	Cluster
1	50.6057	43.6070	5.6528	0.1346
2	60.4587	38.2569	1.2844	-
3	41.7910	53.2338	4.9751	-
4	54.5012	41.3625	3.6496	0.4866
5	44.3689	50.0378	5.3666	0.2268

Table 6. The Distribution of Occupations per Cluster (%)

Cluster	Housewife	Professional	Private Employee	Civil Servant	Part-Time/Freelance	Entrepreneur	Student	Other	Unemployed
1	1.6151	-	53.9704	7.2678	2.9610	-	18.9771	15.2086	-
2	1.7431	-	57.5229	8.6239	2.9358	-	19.8165	9.3578	-
3	0.9950	-	59.8259	14.3035	2.8607	-	11.8159	10.1990	-
4	-	6.8127	-	0.9732	22.1411	41.8491	-	-	28.2238
5	2.1164	-	65.1550	6.7271	0.1512	-	11.7158	14.1345	-

Table 7. The Distribution of Internet Access Time Ranges per Cluster (%)

Cluster	00.01-06.00	06.01-12.00	12.01-18.00	18.01-24.00
1	24.8991	75.1009	-	-
2	0.1835	12.0183	28.0734	59.7248
3	-	-	28.6070	71.3930
4	2.6764	18.2482	26.2774	52.7981
5	-	-	29.4029	70.5971

Table 8. The Distribution of the Most Frequently Performed Internet Activities per Cluster (%)

Cluster	Communicating via Text Messages (WhatsApp/Telegram, etc)	Entertainment	Online Gaming	Searching for Information/Browsing the Internet (Google/Safari/etc)	Using Social Media	Online Shopping
1	77.1198	1.4805	1.0767	9.4213	10.6326	0.2692
2	-	-	0.8257	16.2385	82.0183	0.9174



3	85.3234	4.4776	1.3682	8.3333	0.4975	-
4	56.4477	2.9197	2.4331	12.4088	25.5474	0.2433
5	89.6447	4.0816	0.9826	5.2154	0.0756	-

Table 9. The Distribution of The Most Frequently Used Social Media Platforms per Cluster (%)

Cluster	Facebook	Instagram	Telegram	TikTok	X	WhatsApp	Youtube	Others
1	0.2692	15.2086	0.4038	5.6528	4.7106	68.6406	3.3647	1.7497
2	1.7431	44.6789	-	13.4862	9.9083	27.6147	1.2844	1.2844
3	0.1244	18.4080	0.7463	5.9701	5.2239	66.7910	2.2388	0.4975
4	0.4866	27.7372	0.4866	9.7324	5.1095	52.3114	3.4063	0.7299
5	0.6047	19.3500	0.0756	7.1807	3.0990	65.5329	3.4769	0.6803

Table 10. The Distribution of The Duration of Social Media Access per Cluster (%)

Cluster	0-2 hours	3-5 hours	5-7 hours	More than 7 hours
1	19.7847	40.6460	21.3997	18.1696
2	16.8807	49.1743	21.2844	12.6606
3	18.0348	46.3930	20.0249	15.5473
4	14.3552	41.3625	24.5742	19.7080
5	18.8964	41.5722	21.3908	18.1406

Table 11. The Distribution of Classification of Digital Literacy per Cluster (%)

Cluster	Very Low	Low	Satisfactory	High	Very High
1	-	-	2.8264	67.5639	29.6097
2	-	-	1.6514	57.4312	40.9174
3	-	-	2.9851	-	97.0149
4	-	-	2.4331	69.8297	27.7372
5	-	-	1.5117	98.4883	-

Overall, Cluster 1,2, and 4 were predominantly composed of Generation Z students, whereas Cluster 3 and 5 were predominantly Generation Y. Private employees dominated Clusters 1,2,3, and 5, while Cluster 4 was dominated by entrepreneurs. Cluster 1 primarily accessed the internet in the morning, whereas Clusters 2-5 predominantly accessed it in the evening. Instant messaging was the most frequent internet activity in Clusters 1,3,4, and 5, while social media use dominated Cluster 2. WhatsApp was the most frequently used social media platform in all clusters except Cluster 2, where Instagram was dominant. Across all clusters, 3-5 hours was the most common duration of daily social media use.

Digital literacy was generally high across all clusters. Cluster 1 consisted of 67.56% High and 29.61% Very High, while Cluster 2 consisted of 57.43% High and 40.92% Very High. Cluster 3 showed the highest proportion in the Very High category (97.01%), whereas Cluster 4 consisted of 69.83% High and 27.74% Very High. In contrast, Cluster 5 was predominantly classified as High (98.49%). No students in any cluster were classified as Very Low or Low.

Discussion

Cluster Characteristics and Digital Literacy

The cluster distribution provides important information about the digital literacy and digital behavior of new students at Universitas Terbuka Jakarta. Cluster 5 was the largest group. With 1,323 students, whereas Cluster 4 was the smallest, with 411 students. Across all clusters, the absence of Very Low and Low classifications indicates a relatively high baseline of digital literacy, which is important for students in an open and distance learning environment. Cluster 1 and Cluster 2 predominantly consisted of Generation Z students and demonstrated relatively high digital literacy, but their digital behavior differed. Cluster 1



primarily accessed the Internet during morning hours (06.01-12.00), whereas Cluster 2 preferred evening Internet use (18.01-24.00). Cluster 1 had 67.56% of students classified as High and 29.61% as Very High, while Cluster 2 had 57.43% as High and 40.92% as Very High. These findings generally support Yu (2022), who noted that younger generations are familiar with using digital technologies for social and educational purposes. They also partially support (Prensky, 2001) Digital Native-Digital Immigrant framework, as Generation Z students may be regarded as digital natives because of their extensive exposure to digital technologies. However, the differences between Clusters 1 and 2 indicate that belonging to the same generation does not necessarily result in identical patterns of digital technology use.

Cluster 1 primarily used instant messaging platforms such as WhatsApp and Telegram, whereas social media was the dominant internet activity in Cluster 2, with Instagram as the most frequently used platform. Specifically, 82.02% of Cluster 2 reported social media as their most frequent internet activity, while Instagram was the most frequently used social media platform. The dissimilar online behavior observed between these clusters demonstrates Generation Z students' distinct digital engagement strategies. The preference for social media, particularly Instagram, in Cluster 2 may reflect broader trends in social media usage among younger people. This behavior contrasts with the more communication-oriented activities seen in Cluster 1, suggesting that even within a relatively homogeneous generational group, there are still differences in how digital tools are used. This pattern is consistent with White & Le Cornu (2011) Digital Visitors and Residents framework, which emphasizes that digital engagement is shaped by individuals' motivations and contexts rather than age alone. Thus, the differences between Clusters 1 and 2 suggest that Generation Z students should not be treated as a homogeneous group simply because they belong to the same generation.

The comparison of clusters based on their generational and occupational profiles uncovers differences in digital literacy and behavior, with Cluster 3 standing out due to its unique characteristics. Cluster 3, predominantly composed of Generation Y students (23-38 years old), exhibits the highest level of digital literacy, with 97.01% classified as 'Very High.' According to this study, Generation Y, particularly those in the private sector, may have developed advanced digital competencies due to their exposure to digital technologies during their professional lives. Members of Cluster 3 tend to access the Internet primarily during evening hours (18.01-24.00), a pattern that may be closely tied to their work schedules and family responsibilities. The ability to incorporate digital tools into both professional and personal activities is evident in Cluster 3, which demonstrates advanced digital skills and a disciplined approach to daily routine.

The very high digital literacy observed in Cluster 3 provides an important qualification to Prensky's (2001) framework. Although Generation Y students belong to an older generation than Generation Z, they demonstrate digital competence that is equal to or even higher than that of the Generation Z clusters. This suggests that digital literacy cannot be explained solely by age or generational membership. Instead, professional experience and continuous interaction with digital technologies may also contribute to digital competence, supporting White and Le Cornu's (2011) emphasis on context and patterns of engagement.

Open and distance learning environments may benefit from the relatively strong and structured digital behavior of Cluster 3. Due to their extensive knowledge of the Internet and systematic approach to technology, students in this cohort are expected to be well-prepared for digital learning environments that require self-discipline and proficiency in managing digital content efficiently. Through digital literacy programs and support services, education institutions like Universitas Terbuka can tailor their curriculum to cater to Generation Y



students' unique needs and behaviors, resulting in better outcomes for them in distance learning. Cluster 4 is predominantly composed of Generation Z students, with entrepreneurship as the dominant occupational background. This entrepreneurial characteristic may be associated with their digital literacy and engagement. This cluster has a high digital literacy classification, with 69.83% of students rated as 'High' and 27.74% as 'Very High'. In contrast to other clusters where the private sector is more involved in employment, Cluster 4's primary profession is entrepreneurship.

The internet usage patterns in Cluster 4 serve as additional examples of the individual lifestyles of its members. Most students in this cluster access the Internet predominantly during evening hours (18.01-24.00). Their preference for evening internet usage may be associated with the need to balance academic and entrepreneurial activities. Cluster 4's unique features have practical implications for open and distance learning environments, such as Universitas Terbuka. Modifying educational programs to cater to the unique needs of student entrepreneurs could enhance their learning experience. Integrating learning activities related to digital marketing, e-commerce, and time management could help these students balance their academic and business interests more effectively. By considering the unique demands of entrepreneurial students in Cluster 4, educational institutions can provide more targeted and practical support, which is beneficial for academic success and business expansion.

Cluster 5 predominantly comprises Generation Y students employed in the private sector, with the majority accessing the Internet during the evening hours (18.01-24.00). This cluster is distinguished by a high level of digital literacy, with 98.49% of its members classified as 'High' and 1.51% classified as Satisfactory. The high levels of digital literacy in Cluster 5 indicate that these students may have benefited from their professional experiences in the private sector. The private sector's demands often necessitate ongoing learning and adaptation to new technologies, which may contribute to the high level of digital literacy found in this cluster. Educational strategies in ODL environments should consider Cluster 5's characteristics. These students possess a high level of digital literacy and engage in structured learning, which equips them with the necessary skills to succeed in online learning platforms that require independent study and self-directed learning. Programs designed to meet the needs of Cluster 5's specific digital skills could involve enhancing their proficiency in using advanced digital tools and technologies within their respective professional fields. The outcomes suggest that occupational background may be associated with digital literacy, particularly in clusters with high proportions of entrepreneurs and private sector employees. However, the clustering results do not establish a causal relationship between occupation and digital literacy, especially in contexts where active use of advanced digital tools is common.

Digital Literacy Classification

A comparison of the distributions of digital literacy classification across clusters highlights clear patterns of digital competence among new students at Universitas Terbuka Jakarta. Cluster 3 stands out with 97.01% of its members classified as Very High, whereas Cluster 5 is predominantly classified as High (98.49%). These findings suggest that generational characteristics and professional roles may contribute to differences in digital literacy. For example, students in Cluster 3, mainly comprising Generation Y students, are likely to have developed solid digital competencies through their professional experiences in the private sector, where advanced digital skills are highly sought after. Similarly, the high digital literacy of Cluster 5 may be associated with continued exposure to technology in professional environments. These findings suggest that professional experience may



contribute to digital competence, corroborating findings by Reddy et al. (2023), which emphasized workplace demands in driving skill development.

Conversely, Clusters 1 and 2, primarily Generation Z students, are distributed across the 'High' and 'Very High' categories. This distribution may reflect the diverse digital engagement patterns among Generation Z students, who exhibit differences in their level of digital experience and skill application. The relatively strong digital engagement observed among Generation Z students in this study is consistent with findings from other countries, although the international evidence also demonstrates considerable variation. For example, Sanalan and Taslibeyaz (2020) found that Generation Z university students in Turkiye showed frequent internet and social media use and preferred interactive and flexible technology-supported learning environments. Similarly, Boro, Laltlanzova, and Chanchinmawia (2024) reported that Generation Z university students in India regularly used digital resources in academic environments, while also highlighting the continued need for information literacy, online communication, and cybersecurity skills. These findings indicate that frequent exposure to technology among Generation Z does not automatically imply equal competence across all dimensions of digital literacy.

The present findings are also relevant to recent studies in Open and Distance Learning. Recent research among new ODL students in Indonesia found relatively strong digital skills, digital ethics, and digital culture but identified digital safety as an area requiring further improvement (Kharis et al., 2025). This supports the view that even students with generally high digital literacy may require targeted support in particular dimensions. In addition, studies of online distance learning have emphasized that digital literacy is an important factor in students' effective participation in technology-mediated learning environments. The observed disparities in digital literacy among clusters indicate the importance of designing digital literacy strategies tailored to different student groups' individual interests and needs. In an open and distance learning environment such as Universitas Terbuka, where students come from different ages, locations, and professional backgrounds, it is essential to recognize and address the unique challenges that each group faces in achieving digital fluency. The higher literacy levels of Generation Y students in Clusters 3 and 5 suggest that digital literacy programs for these groups may focus on the latest tools and technologies relevant to their professional fields. Meanwhile, programs that enhance the digital skills of Generation Z students in Clusters 1 and 2 could facilitate their engagement with more advanced virtual environments through practical experience.

Given Universitas Terbuka's objective of providing education to all students regardless of age and profession, it is crucial to consider generational and job differences when designing digital literacy programs. However, the findings also indicate that generation should not be used as the sole basis for designing such programs. Adapting these programs to the diverse interests and digital engagement patterns of students may improve individual learning experiences and the university's open and distance learning model's overall effectiveness. By focusing on each cluster's specific digital literacy challenges, Universitas Terbuka can ensure that all students, regardless of their background, are prepared for success in their studies and careers.

Conclusion

The K-Means analysis $k = 5$ identified distinct student profiles and showed that digital literacy among open and distance learning (ODL) students is not determined solely by age or generation. Although Cluster 1, 2, and 4 were dominated by Generation Z students, they exhibited different patterns of digital behaviour and literacy, while Clusters 3 and 5, both



dominated by Generation Y students, also differed in literacy classification, with Cluster 3 predominantly Very High (97.01%) and Cluster 5 predominantly High (98.49%). These findings indicate that digital literacy is also associated with occupational background and patterns of technology use, suggesting that digital literacy programs should be tailored to the characteristics of each student cluster.

Recommendation

Based on the findings, Universitas Terbuka should develop targeted digital literacy initiatives according to the characteristics of each student cluster. First, pedagogical and curriculum interventions should integrate practical competencies, including academic use of digital tools, information evaluation, digital communication, and technology-supported learning activities. Second, institutional and technological support should be strengthened through collaboration among IT services, curriculum developers, and appropriate digital resources. Third, targeted skill enhancement should address specific demographic needs, such as advanced digital skills for Generation Y professionals, digital entrepreneurship and online business skills for student entrepreneurs, and more advanced academic uses of technology for Generation Z students. These strategies can support more adaptive and inclusive ODL while responding to the distinct needs identified across the five clusters.

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