Evaluating Digital Intelligence on Growth Mindset Focus: Q-Methodology Study on Students' Openness

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Abstract: Global competitiveness emphasizes that nations with digitally literate and adaptable populations are likely to be more competitive in the global economy. In the contemporary global landscape, technology plays a pivotal role in economic growth, innovation, and competitiveness. Nations that prioritize the development of digital skills and foster a growth mindset among their populations are better positioned to thrive in the digital age. Moreover as technology continues to evolve, there is a need to understand how individuals integrate and adapt to new digital tools. Another significant aspect is that higher educational institutions can play a crucial role to ensure that graduates are well-prepared to meet the complex requirements of the new digital world. The aim of the research is to explore university students' digital intelligence (DQ) levels from the view of growth mindset. More specifically, understanding how the mindset of students contributes to their openness related to developing the different levels of DQ. The research applied Q-methodology, that allows to capture the diverse perspectives of students, providing a nuanced understanding of their openness to DQ maturity. Different individuals have distinct views on how it relates to a growth mindset, and the strategies they believe are effective for developing digital skills. Findings from this research offer implications for educational policies and curriculum development, ensuring that educational institutions are preparing students for the challenges and opportunities presented by the digital landscape. Moreover it allows educators to tailor teaching methods and curriculum design to enhance students' digital literacy and adaptability. It provides insights into the psychological and behavioral aspects of learning in a digital context. From a theoretical aspect the study contributes to understanding the cognitive processes involved in students' decision-making and attitudes towards different levels of DQ, considering the phenomenon of growth mindset.

Keywords: Digital Intelligence, Growth Mindset, Q-Methodology Study, Students' Openness

1. Introduction

Digital Intelligence (DQ) is crucial for global competitiveness, driving economic success in the digital age (Manasia, Pârvan & Ianos, 2018). Embracing a growth mindset is essential for individuals to adapt to the evolving digital landscape and continuously develop their DQ (Zhang, 2023). DQ encompasses a broad range of digital competencies rooted in universal moral values, empowering individuals to use, control, and innovate with technology (Park & Gentile, 2019). It is a lifelong journey of learning and adaptation, requiring a commitment to continuous improvement (Pornpongtechavanich & Wannapiroon, 2021; Zhang & Farooq, 2021). By investing in digital literacy and skills development, countries can drive sustainable growth, prosperity, and inclusive development (Sharma et al, 2016).

The rationale for exploring university students' DQ from a growth mindset perspective is multifaceted, aiming to enhance learning outcomes, address digital skills gaps, promote lifelong learning habits, prepare students for future success, and optimize educational interventions. Furthermore, the application of Q-methodology in this research could provide a valuable approach by capturing diverse perspectives, exploring subjectivity, identifying contrasting views, and thereby informing educational practice and policy to better support students in acquiring the digital skills needed to thrive in today's digital age.

Therefore, the aim of the research is to explore the diverse perspectives behind students' DQ levels in the context of growth mindset. More specifically, the aim is to investigate different perspective groups regarding how students perceive various elements of DQ in relation to their own developmental aspirations.

The following research question was formulated based on the aim:

RQ1. What are the different perspective groups among university students regarding their beliefs about the potential for growth and improvement in DQ?

This aim aligns well with the principles of growth mindset theory (Dweck, 1999), which emphasizes the importance of effort, perseverance, and a belief in the potential for growth and improvement. By exploring this, the research has the potential to provide a more nuanced understanding of the complex interplay between growth mindset and DQ levels.

This research not only contributes theoretically but also raises awareness among students about essential competencies for successful navigation in the digital realm. Participation offers students insights into areas for improvement, enhancing their understanding of strengths and weaknesses in terms of Digital Intelligence (DQ). It also highlights the significance of achieving higher DQ levels, guiding the design of educational programs tailored to students' developmental needs and expectations in the digital domain. This research covers the conceptualization of DQ and growth mindset, their relationship, and prior studies in higher education (Section 2), followed by methodology explanation (Section 3) and results analysis (Section 4). Finally, it discusses educational implications and future directions (Section 5).

2. Literature Review

2.1 Conceptualization of DQ and Growth Mindset

As the above mentioned definition explains, DQ encompasses a wide range of digital competencies grounded in fundamental moral values. It empowers individuals to effectively utilize, manage, and innovate with technology to drive human progress (Park & Gentile, 2019). The holistic conceptualization of DQ recognizes the importance of equipping individuals with the skills and mindset needed to thrive in an increasingly digital world. According to DQ Institute DQ is characterized as a holistic collection of technical, cognitive, meta-cognitive, and socio-emotional proficiencies deeply rooted in universal moral principles. These proficiencies empower individuals to confront the complexities and capitalize on the advantages presented by digital environments (Park, 2023). The formulation of the DQ framework (developed by DQ Institute) was guided by the transformative impact of technology on our social and professional interactions, prompting the incorporation of cognitive abilities alongside technical skills to effectively navigate interpersonal dynamics, conflicts, and negotiations (Park & Gentile, 2019). This DQ framework encompasses eight key domains, each comprising competencies delineated across three proficiency levels. By categorizing DQ into three maturity levels—digital citizenship, digital creativity, and digital competitiveness—a comprehensive understanding of digital capabilities is facilitated. Aligned with these DQ levels are the delineated eight areas, yielding a total of twenty-four competencies. These areas and competencies facilitate tailored learning experiences that address the immediate relevance of various aspects of individuals' lives (Park & Gentile, 2019). Moreover, the components of DQ according to the definition contain several factors. DQ encompasses various types of competences that individuals need to navigate effectively in a digital environment. This includes knowledge elements (e.g. digital literacy or knowledge about digital security (Dostal et al, 2017)), skills and abilities (e.g. operational, informational, strategic and digital fluency (Cismaru et al, 2018)) and values or attitude elements (e.g. a disposition, a mindset to act (Vuorikari, Kluzer & Punie, 2022)). Moreover, DQ is a complex phenomenon that is based on universal moral values such as honesty, integrity, respect, empathy, and responsibility, and these values serve as guiding principles for ethical behavior and decision-making in digital spaces (Park & Gentile, 2019). DQ equips individuals with the capabilities to address the diverse challenges they encounter in digital life such as cyberbullying, online privacy and security risks, misinformation, digital addiction, and digital divide, among others (Park, 2023). Beyond managing challenges, DQ enables individuals to leverage the myriad opportunities presented by digital technologies such as using digital tools for learning, communication, collaboration and so on (Avci & Adiguzel, 2020). Both DQ and the growth mindset advocate for a holistic approach to personal development, recognizing the interconnectedness of technical, cognitive, and socio-emotional competencies in navigating digital environments.

The concepts of fixed and growth mindset introduced by Dweck (2008) describe variations in individuals' beliefs regarding "the potential for change in fundamental personal attributes like intelligence or abilities, leading to distinct patterns of judgment and response across various tasks and contexts" (Solberg et al., 2020, p. 108). Believing in the potential for growth, adaptability, and the capacity to learn from experiences characterizes a growth mindset, while attributing personal traits to fixed qualities defines a fixed mindset (Dweck, 2008), and these outlooks significantly impact individuals' behaviors and ultimately influence their accomplishments. Masters (2014) demonstrated that a growth mindset correlates with positive learning behaviors among students, while Claro, Paunesku & Dweck (2016) enhances the impact on academic performance and fosters resilience in the face of academic setbacks (Dweck, 2000).

Summarizing the above mentioned concept, we conclude that the holistic conceptualization of DQ emphasizes a wide array of technical, cognitive, and socio-emotional competencies rooted in universal moral values, empowering individuals to navigate digital environments effectively, while the principles of a growth mindset,

which prioritize adaptability and learning from experiences, intersect with DQ, contributing to positive learning behaviors and academic performance among students.

2.2 The Link Between DQ and Growth Mindset, and Prior Researches in Higher Educational Settings

The intersection of DQ and growth mindset is evident in various aspects. Research by Dweck (2000) illustrates how individuals' mindsets, particularly in educational and professional settings, influence their adaptability and willingness to embrace change. The coexistence of physical and cyber space has given rise to a new mindset, particularly among younger generations immersed in digital technologies (Kineshanko & Jugdev, 2018) moreover the exploration of how digital learning contributes to the development of DQ. Santos et al (2017) emphasize the increasing importance of digital competencies in the context of the Fourth Industrial Revolution, highlighting the need for individuals to navigate the digital landscape effectively. Central to this discussion is the notion of being a changemaker in the digital environment, where organizational policies play a crucial role in delineating boundaries between personal, professional, and public communication (Banghart, Etter & Stohl, 2018). The growing demand for DQ, driven by economic imperatives and competitive pressures, underscores the significance of lifelong learning initiatives that address evolving market demands (Curran, Garrett & Puthiyamadam, 2017). However, criticisms have been levied against educational institutions for prioritizing market-driven skills development over holistic personal growth and community-building (Conley & Rauth, 2020; Barnett, 2007).

The research of Loble, Greenaune & Hayes (2017) underscores the importance of students' ability to perceive challenges and failures as opportunities for growth rather than obstacles. Embracing learning as a lifelong journey, with perseverance and a willingness to take intellectual risks, is crucial for success in the evolving digital world. A supportive ecosystem comprising physical and emotional well-being, access to technology, and a growth mindset is essential for effective technology utilization among students (Thomas et al., 2024). This highlights the significance of fostering not only technical skills but also a resilient and adaptable mindset to navigate the complexities of the digital age. Moreover, as advanced technologies reshape the landscape of the workplace, there is a growing demand for individuals, teams, and organizations to embrace adaptability and resilience (Trenerry et al., 2021). Programs and training aimed at cultivating workplace resilience and fostering a mindset shift towards adaptability are essential in the face of ongoing digital disruptions.

Lastly, individual attitudes and mindsets toward job roles and professional development play a crucial role in building resilience during challenging times (Cameron and Brownie, 2010).

This highlights the need for a balanced approach that not only equips individuals with technical skills but also fosters psychological development and creates supportive learning communities. In essence, the convergence of DQ and growth mindset underscores the importance of adaptable, resilient individuals who are capable of thriving in an ever-evolving digital landscape while also nurturing their personal and professional development.

3. Methodology

Q-methodology, renowned for its blend of quantitative and qualitative analyses, is a robust research approach used across various fields to explore competencies and attitudes (Watts & Stenner, 2012). By employing factor analysis, it unveils distinct viewpoints on a topic, as observed in studies spanning nurse education, critical thinking, teacher evaluation, and HRM competency rating (Hensel et al., 2022; Gyenes, 2021; Bogdány, Cserháti, Raffay-Danyi, 2023). While ensuring consistency across samples, its focus on qualitative evidence limits generalizability (Thomas & Baas, 1992). Despite its time-consuming nature, Q-methodology offers valuable insights and aids informed decision-making in higher education settings by aligning curricula with evolving labor market demands (Aldamen et al, 2021). Thus, it serves as a potent tool for identifying and prioritizing competencies crucial for navigating the digital world effectively (Morea, 2022).

The participant selection and recruitment procedures involved targeting higher educational students in their last semester of study. The choice of students in their final semester was deliberate, as this group is poised to transition from academia to the professional world, making their perspectives particularly relevant for understanding developmental aspirations. Participants were selected using purposive sampling, a common approach in Q-methodology (Atwal & Caldwell, 2005), which focuses on selecting individuals who can provide articulate viewpoints on the topic of interest. Specifically, students were chosen based on their ability to articulate their viewpoints on digital quotient (DQ) elements and their relevance to future career aspirations and educational goals. A total of 51 full-time students from the Faculty of Business and Economics were invited

to participate in the survey, of which 46 provided assessable responses (Table 1 present the main characteristics of the sample). This sample size aligns with typical Q-methodology studies, which generally include around 40-60 participants. The rationale for this range is rooted in the methodology's use of inverted factor analysis, which does not aim for generalization to a larger population but rather seeks to identify and analyze distinct viewpoints within a specific group.

Table 1: Sample characteristics

Gender			Age			Age when you started using an electronic device	
	N	Percent		N	Percent		
man	11	23,91%	18 - 20	4	8,70%	Mean	9,91
woman	35	76,09%	21 - 23	33	71,74%	St. Deviation	2,67
Total	46	100,00%	24 - 26	7	15,22%	Median	10
			27 -	2	4,35%		
			Total	46	100,00%		

The survey was administered during a scheduled lesson, facilitating convenient data collection. The survey included elements for ranking DQ elements in the light of developmental aspirations. By focusing on students nearing the completion of their academic programs, the study aimed to capture insights into how these individuals perceive DQ in relation to their future career aspirations and educational goals. By capturing their perspectives during this critical phase, the study provides valuable insights into how students nearing graduation view DQ elements, which can inform educational strategies and career readiness programs.

The following steps of Q-methodology were applied during the research (Table 2).

Table 2: Stages of applied Q-methodology

Stages	Description	Output
Development of concourse	Compilation of Q-sample: compilation of the statements of DQ elements' based on the integration of knowledge, skill, attitude and examples of DQ Institute's DQ Framework and DigComp 2.2 regarding to growth mindset	Q-set: 24 different statements in the light of growth mindset
Selection of P-Sample	Full-time higher educational students in their last semester of study were selected	P-Set: 51 students
The establishment of Q-sorts	Ranking procedure whereby students were asked to rank Q-set according to growth mindset	46 individual Q-sorts
The standard analytical process - Factor analysis	Using PQMethod software Centroid factor analysis, and Varimax Rotation: identifying distinct perspectives, exploring the underlying beliefs or attitudes within each perspective,	3 emergent factor
The interpretation of factors and results	Interpreting the factors, distinguished statements, and Z-score values to gain a deeper understanding of the different perspectives represented in the data. Discussing the implications of findings and how they contribute to the overall understanding of the research topic.	Research proposals, implications

The DQ ranking survey comprised a list of DQ elements derived from several sources. The DQ elements were developed based on established frameworks such as the DQ Institute and DigComp 2.2 (Digital Competence Framework). These frameworks provided comprehensive guidelines and standards for digital competence, encompassing a wide range of knowledge, skills, and attitudes. Each DQ element was accompanied by a coherent definition that clearly delineated its components. Definitions were structured to encompass knowledge, skills, and attitudes, ensuring a holistic understanding of each element. This approach allowed participants to evaluate DQ elements comprehensively and accurately. To provide context and clarity, examples were included for each DQ element. These examples illustrated how the knowledge, skills, and attitudes associated with each element might manifest in real-world scenarios. By incorporating examples, participants were better able to understand the practical implications of each DQ element and make informed judgments during the ranking process.

Participants were asked to rank DQ elements based on the prompt: "I'm willing to look to develop myself in the following areas by the right investment of time and energy...". Participants were instructed to rank the DQ

elements according to their perceived relevance, providing quantitative data on their preferences in DQ development.

Due to the extensive nature of the questionnaire, administered through the Q-methodology ranking method, and the intricate interconnections among DQ elements, completing the survey necessitated careful deliberation. Respondents followed predefined steps outlined by Watts and Strenner (2012), to complete the ranking process, resulting in individual Q-sorts reflecting participants' unique perspectives.

4. Results

After considering the different factor solutions, 3 factors emerged, whereby the average squared residual correlation was 0.036. Table 3 displays the different correlations between factor scores, the number of participants in each group and the reliability of the construct.

Table 3: Correlation between factor scores, the number of participants in each group and reliability

Factors	1	2	3
1	1.0000	0.0855	-0.1412
2	0.0855	1.0000	0.1983
3	-0.1412	0.1983	1.0000
No. of defining variables (participants in the group)	15	14	10
Composite reliability	0.984	0.982	0.976

Drawing from the provided approach, it was found that 7 students remained unclassified, while 39 participants were successfully categorized into distinct groups. The composite reliability of Q-sort items played a pivotal role in determining the reliability of factors. The study identified three discernible factors, each exhibiting composite reliability values ranging from 0.976 to 0.984, signifying a high level of consistency and reliability in the instrument employed, albeit with an emphasis on participants' subjectivity in Q-methodology. The interpretation of emergent factors was guided by the unique sets of perspectives associated with factor scores.

In the subsequent section, emergent factors were interpreted based on the distinctive perspectives of respondents regarding their growth mindset towards DQ elements (as presented in Table 4). Subsequently, significant distinguishing and consensus statements were elucidated.

Table 4: Factor scores with corresponding ranks and significantly distinguishing statements

	Factor 1		Factor 2		Factor 3	
	Z-SCR	Rank	Z-SCR	Rank	Z-SCR	Rank
Digital Citizen Identity	-0.04**	12	-0.82**	20	-1.60**	23
Balanced Use of Technology	1.44	2	0.38**	8	1.68	1
Behavioural Cyber-Risk Management	-1.09*	21	-0.41	18	-0.63	18
Personal Cyber Security Management	-1.11**	22	1.46	4	1.20	4
Digital Empathy	1.26**	5	0.57**	7	-1.33**	21
Digital Footprint Management	-0.77**	17	-1.24**	22	0.51**	9
Media and Information Literacy	1.57	1	-0.13**	11	1.27	3
Privacy Management	-0.10**	14	1.74**	1	0.76**	6
Digital Co-Creator Identity	0.11*	10	-0.36	17	-0.55	17
Healthy Use of Technology	1.41	3	1.72	2	0.39**	11
Content Cyber-Risk Management	-0.79*	18	-0.34*	16	0.25**	12
Network Security Management	-1.27**	23	1.55**	2	0.45**	10
Self-Awareness and Management	1.21**	6	-0.28*	15	-0.79*	19
Online Communication and Collaboration	0.84	7	0.71	6	0.17**	13
Content Creation and Computational Literacy	-0.60**	15	-1.92**	24	0.56**	7
Intellectual Property Rights Management	-1.03**	20	-0.20**	12	0.52**	8
Digital Changemaker Identity	0.22*	9	-0.20*	13	0.88**	5
Civic Use of Technology	0.01	11	-0.23	14	-1.92**	24
Commercial and Community Cyber-Risk Management	-0.84*	19	0.84**	5	-0.35*	16
Organisational Cyber Security Management	-1.61**	24	0.27	10	-0.10	15
Relationship Management	1.38**	4	0.29**	9	-1.53**	22
Public and Mass Communication	0.55**	8	-1.50*	23	-1.02*	20
Data and AI Literacy	-0.70	16	-0.73	19	1.27**	2
Participatory Rights Management	-0.05	13	-1.15**	21	-0.09	14

Label: (Z-SCR) Z Score Value, (*) P<0.0.5, (**) P<0.01)

Factor_1: This group of respondents emphasizes digital interactions, valuing not only technical proficiency but also social and ethical considerations. They prioritize elements such as Digital Empathy, Self-Awareness and Management, and Relationship Management, indicating a focus on social responsibility and effective communication. Distinguished statements highlight the importance of these elements in fulfilling the respondents' developmental aspirations. The distinguished statements, identified by their Z-score values, further elucidate the importance of certain DQ elements within factor_1. Notably, Digital Empathy, Self-Awareness and Management, Relationship Management, and Public and Mass Communication emerge as particularly salient DQ elements, indicating their alignment with the developmental aspirations of the respondents. Conversely, statements related to aspects such as Organizational Cyber Security Management and Network Security Management exhibit lower Z-score values, suggesting their relatively lower importance in fulfilling the respondents' developmental aspirations within the digital landscape.

Factor_2: Students in this factor prioritize security and responsible digital behavior, as evidenced by their emphasis on elements such as Privacy Management and Personal Cyber Security Management. They also value elements related to social intelligence, such as Digital Empathy and Relationship Management. The distinguished statements further underscore the significance of privacy and security in fulfilling students' developmental aspirations. The distinguished statements further elucidate the significance of certain DQ elements within the respondents' perceptions. Privacy Management, Network Security Management, and Public and Mass Communication emerge as particularly salient DQ elements, indicating their importance in fulfilling students' developmental aspirations. Conversely, elements such as Digital Footprint Management and Content Creation and Computational Literacy exhibit lower Z-score values, suggesting their relatively lower importance within the respondents' perceptions.

Factor_3: This group of students demonstrates a diverse range of competencies and skills related to digital literacy, security, creativity, and social impact. They prioritize elements such as Media and Information Literacy, Data and AI Literacy, and Digital Changemaker Identity, indicating a desire for proficiency in navigating digital content and making a positive impact in the digital realm. Distinguished statements highlight the importance of privacy, data literacy, and social impact in fulfilling students' developmental aspirations. The distinguished statements, identified by their Z-score values, further elucidate the significance of certain DQ elements within the respondents' perceptions. Notably, Privacy Management, Data and AI Literacy, and Digital Changemaker Identity emerge as particularly salient DQ elements, indicating their importance in fulfilling students' developmental aspirations. Conversely, statements related to aspects such as Civic Use of Technology and Relationship Management exhibit lower Z-score values, suggesting their relatively lower importance within the respondents' perceptions.

Answering to the RQ1. (What are the different perspective groups among university students regarding their beliefs about the potential for growth and improvement in DQ?), the findings suggest that students' perceptions of DQ vary based on their developmental aspirations, with some prioritizing social responsibility and effective communication, others focusing on security and responsible digital behavior, and still others valuing proficiency in digital literacy, creativity, and social impact.

5. Discussion

The literature underscores the significance of Digital Intelligence (DQ) in global competitiveness and individual development, with results revealing how individual mindset differences influence various DQ contexts (Manasia, Pârvan & Ianos, 2018; Sharma et al., 2016; Park & Gentile, 2019; Park, 2023). The three factors elucidate diverse perspectives on DQ, reflecting respondents' developmental aspirations ranging from social impact to security to creativity. Understanding these factors informs educational strategies catering to students' varying developmental priorities in the digital age (Park & Gentile, 2019; Park, 2023; Avci & Adiguzel, 2020). Factor 1 prioritizes a balanced approach, emphasizing digital co-creation and social impact, while Factor 2 focuses on security and responsible behavior. Factor 3 encompasses a multifaceted understanding, emphasizing critical thinking, creativity, and ethical considerations, highlighting the complex nature of DQ (Park & Gentile, 2019; Park, 2023). These insights underscore the importance of tailored educational interventions addressing diverse developmental aspirations and priorities in the digital landscape.

By tailoring programs to address specific areas highlighted by factors, such as social responsibility, cybersecurity, and creativity, universities can promote holistic DQ development (Dostal et al, 2017; Park & Gentile, 2019; Park, 2023). Initiatives should focus on enhancing skills in privacy management, content creation, and problem-solving to empower students in digital environments (Zhang, 2023). Practical implications suggest targeting

interventions based on identified proficiency gaps and fostering a culture of lifelong learning (factor_1, factor_2, factor_3). Theoretical contributions lie in integrating DQ with growth mindset, offering insights into how beliefs about growth influence digital skills development, and providing a foundation for further research (Zhang, 2023). This study highlights the importance of tailored educational interventions and the dynamic interplay between DQ and growth mindset, advancing theoretical discourse and informing future research directions.

6. Conclusion

In conclusion, our research findings shed light on the diverse perspectives among university students regarding their beliefs about the potential for growth and improvement in DQ. Factor_1 respondents prioritize digital interactions, emphasizing not only technical proficiency but also social and ethical considerations. Elements such as Digital Empathy, Self-Awareness and Management, and Relationship Management are deemed particularly salient, reflecting a focus on social responsibility and effective communication. Conversely, Factor_2 students prioritize security and responsible digital behavior, with Privacy Management and Personal Cyber Security Management taking precedence. Factor_3 students demonstrate a diverse range of competencies, prioritizing elements such as Media and Information Literacy and Data and AI Literacy, indicative of a desire for proficiency in navigating digital content and making a positive impact in the digital realm.

These findings underscore the importance of considering students' developmental aspirations in understanding their perceptions of DQ and growth mindset. By recognizing these diverse perspectives, educational interventions and policies can be tailored to better support students in acquiring the digital skills needed to thrive in today's digital age. Further research should explore the interplay between growth mindset and DQ to develop more targeted curriculum development strategies and educational interventions aimed at fostering a growth mindset and enhancing DQ maturity among students.

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