

¹Hou Yanlin²Mohamad
Abdillah Bin
Royo

Accessibility and Effectiveness of Online Learning in China's Vocational Education System: A Comparative Study between Urban and Rural Areas



Abstract: - The rapid expansion of online learning in China has revealed significant disparities between rural and urban vocational students, necessitating a thorough investigation. This study explores the accessibility and effectiveness of online education in both urban and rural settings, focusing on key dimensions like internet availability, device readiness, digital literacy, infrastructure support, LMS adoption, feedback methods, student engagement, and satisfaction. Data was collected from 314 participants, and statistical techniques including the Mann–Whitney U test and Pearson correlation were employed for analysis. The study delved into six crucial areas related to online learning accessibility and academic performance, utilizing Principal Component Analysis (PCA) to understand complex interrelationships among variables. The findings indicated that rural students consistently scored lower in all aspects of online learning accessibility ($p < 0.01$) compared to urban counterparts. Moreover, rural vocational learners exhibited lower engagement and satisfaction levels in online education, resulting in lower academic achievement than their urban peers. The strong correlations among these parameters highlight the need for integrated interventions to bridge the digital divide. In conclusion, this study underscores the urgency of targeted interventions to address the digital divide between urban and rural areas in China.

Keywords: Online Learning, Effectiveness, Rural-Urban Divide, Vocational Students, Digital Literacy

1. Introduction

With the rise of digital technology, online courses have been systematically incorporated into education systems around the world (Singh & Thurman, 2019). The move towards online education on a world-wide scale is another indicator that the age of digitalisation has arrived. This is especially the case in education where it has significantly hastened global digitalization. A total of 290 million students in schools all over the world are affected by mass closures and social distancing regulations that seek to move from conventional classrooms into online platforms (Siddiquei & Kathpal, 2021). Though there were some initial problems with this radical transformation, new opportunities arose to carry the studies forward in online learning. Even during the current worldwide outbreak of pandemic, many countries were able to use their advanced technological infrastructures to execute sweeping online learning programs (Murad et al., 2020; Wester et al., 2021). Thus, with the lockdown many students choose to use online learning platforms in order to continue their studies (Dutta, 2020 ; Mathivanan, 2021). This burst of users showed that online learning could bring more students closer, even in an emergency situation.

In the midst of COVID-19, vocational education has also been strengthened by incorporating online learning modes. Vocational education is the teaching of technical instruction and skill training, focusing on occupations that require practical knowledge (Pambudi & Harjanto, 2020). With respect to this topic, online learning in vocational education has received considerable attention from international scholars (Edy, 2020; Huwaidi, Nandiyanto & Muhammad, 2021; Sangsawang, 2020). In terms of vocational education, online learning can make the training for practical skills more convenient and allow individualized study schedules (Edy, 2020). In this way, the researchers also survey whether online learning has become a part of vocational education and affirm that internet-based resources, open platforms and innovative teaching methods are all with fairly great significance to practical in forays into new realms (Syauqi, Munadi & Triyono, 2020). Thus, online learning in vocational education provides accessibility, adaptability, and many dynamic instruments for skill improvement.

Nevertheless, the transition from conventional educational methods to online curriculum was full of challenges. Although the Internet has made it possible for students to keep studying amidst the global pandemic, it has also

¹Faculty of Social Sciences and Humanities, School of Education.Universiti Teknologi Malaysia, Malaysia. (elika_lin@163.com)

²Faculty of Social Sciences and Humanities, School of Education.Universiti Teknologi Malaysia, Malaysia. (Evangeline_1983@163.com)

Corresponding author: Mohamad Abdillah Bin Royo ,

Email: Evangeline_1983@163.com

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exacerbated existing inequalities in educational opportunities. A notable disparity in the accessibility of online learning is related to the presence or absence of internet connectivity (Hamid, SENTRYO & HASAN, 2020; Abdulmajeed, Joyner & McManus, 2020). Despite the importance of constant internet access for online education, it was rare for everyone. As Ferri (2020) pointed out, students from low socioeconomically disadvantaged backgrounds or middle-class families often faced problems such as unreliable and substandard internet connections, which confined them to being mere passive recipients in online education settings. In a similar vein, Gu et al. (2022) also showed that among children in China who engage in at-home online education, low-income and low-status households face very great difficulties when it comes to accessing broadband Internet (Gu, 2022).

Secondly, device accessibility, which includes computers, tablets, and smartphones, is another area of significant obstacle since not all students necessarily have these tools for educational use (Hasan & Khan, 2020). The third obstacle is linked to digital literacy, or competence in technological skills and being able to understand the information that comes from computer systems. Lack of digital literacy often means that students need help in their education, particularly as they transition to online learning (Barrot, Llenares & Del Rosario, 2021). In the same way, Putri et al. (2020) find that a significant obstacle to online learning is technical incompetence, which hinders the effectiveness of e-learning (Putri et al., 2020). Another major obstacle is a lack of infrastructure, which includes digital technology as well as providing physical spaces that enable learning and education (Ntorukiri, Kirugua & Kirimi, 2022; Akram, 2022). Thus, research has shown that teachers must comprehend student comments to improve learning in online learning (Nguyen, 2017). In particular, activities in which teachers and students work together to solve problems will positively affect students' learning outcomes (Syauqi, Munadi & Triyono, 2020; Kang & Im, 2013).

Moreover, online learning has produced varied outcomes concerning effectiveness, presenting benefits and drawbacks for students. Some students have found that online learning is advantageous, which has enhanced their academic performance (Ulum, 2022). According to Müller (2023), the adaptability and simplicity of online platforms allow students to personalise their learning schedules, which may facilitate their engagement with the course material during their most productive periods (Müller, Mildemberger & Steingruber, 2023). In this regard, Fanguy (2018) also showed that the capability to rewind and review lectures enhances the understanding and review of intricate subjects (Fanguy et al., 2018). Thus, using additional learning materials and implementing self-directed learning can significantly improve the understanding and long-term retention of information.

Nevertheless, it is essential to acknowledge that online learning can present specific difficulties that have the potential to impact the academic achievements of students adversely (Basar et al., 2021). The inability to ask teachers questions directly in natural settings and receive prompt answers becomes a major drawback of online learning (Putri et al., 2020; Hollister et al., 2022). The presence of technical challenges, such as the restricted availability of essential technology, can impede the capacity of students to engage thoroughly and achieve satisfactory outcomes (Almaiah, Al-Khasawneh & Althunibat, 2020; Aboagye, Yawson & Appiah, 2021). It demonstrates that there are several advantages and disadvantages to the effectiveness of online learning in terms of learning outcomes for students.

In terms of education, the state-run education system in China has graduated 8 million university students in the last decades, making it one of the leading higher education systems in the world (Mok, 2021). Consequently, China has emerged as a prominent global education market, generating an estimated revenue of USD 300 billion (Gulati, 2020). However, it has been noted that the coronavirus pandemic has led to a circumstance in which online education has attained an unprecedented degree of extensive usage and acknowledgment among users in China (Xiong, Ling & Li, 2021). According to Statista (2021), the online education industry in China grew to over 423 billion yuan in 2020, with 331 million users (Textor, 2023). Statista (2022) also forecasted that the online educational market in China is projected to attain a value of 490.5 billion yuan by 2024. In terms of vocational education, the Chinese government has placed significant emphasis on its economic growth and educational agendas, thereby establishing a distinctive model of modernisation for vocational education (Ministry of Education of the People's Republic of China, 2022). As a result, 74.6% of online education income in China came from higher education as well as vocational training (Batinca & Treleaven, 2015). Many studies have been conducted with a specific focus on the progress, effectiveness, and accessibility of online learning education in China. Despite the extensive research conducted on the effectiveness and challenges of online learning in China,

there is a noticeable gap in the existing literature regarding the influence of online learning in the specific context of vocational education. Despite being a fundamental aspect of educational development initiatives in China, vocational education remains an area that has received limited attention in terms of online learning research.

Moreover, although a considerable number of studies have examined the overall challenges and effectiveness of online learning in China, there is a scarcity of research that explicitly analyses these aspects from a geographical standpoint, comparing rural and urban perspectives. Thus, not enough studies have been done on how online learning affects vocational education, which has led to a gap in the study. In addition, China needs to conduct a comparative study on the efficiency and availability of online education from the perspectives of both urban and rural settings. As a result, this research will help policymakers, educators, and technologists improve online learning for all children.

2. Methodology Section

This cross-sectional study looked at the accessibility and validity of online learning within China's vocational education system, focusing on academic results between urban and rural areas. An online manner of data collecting was applied to gather material information using the crowd-targeting capabilities offered by modern data companies. This method of collecting data can ensure getting the relevant information from all sides, including urban and rural. An online survey was sent out through its digital and social media channels run on various platforms, including WeChat, Weibo, QQ, Zhihu (the Chinese version of Quora), Douyin (Chinese TikTok) as well as Baidu Tieba. The platforms for these activities are not limited geographically or demographically, which provides an opportunity to combine social media data with research in the social sciences [40]. The online survey took about 15 minutes to fill out and mainly was closed-ended questions based on items with Likert scales in order for response rates to be as high as possible. These measures were designed to test the perceived levels of access and effectiveness in online learning inside the vocational education system.

The questionnaire was divided into two sections, namely demographic data and the ease with which one can assess online learning. Several aspects of accessibility and effectiveness were included in these sections. The current research investigates how easily accessible and effective online education is in relation to twenty-four different elements, all of which were grouped into eight primary categories. These aspects include the accessibility of the internet and electronic devices, the level of digital literacy among students, the investment in necessary infrastructure, the incorporation of learning management systems (LMS), assessment and feedback mechanisms, student engagement, and satisfaction. A Likert scale of five points was utilised in the questionnaire, ranging from 1 (showing strong disagreement) to 5 (expressing strong agreement). A validation procedure was carried out in SPSS to determine the validity of the questionnaire as well as its level of reliability. Cronbach's alpha showed that the questionnaires consistently exhibited the reliability of their subscales when assessing the accessibility and efficacy of online learning. It was evidenced by a high value of 0.992 for each of the questions.

In order to evaluate the usefulness of online education within the framework of the vocational education system, in addition to distributing questionnaires, academic scores were also obtained from each participant. In the context of this discussion, the term "academic scores" refers to a quantitative evaluation of academic accomplishments that is free of any subjective biases. The results were obtained from the annual examination that was carried out during the year of instruction prior to this one. These online learning resource evaluations assess students' knowledge and skills throughout the school year. Comparing test scores from urban and rural students can illuminate these academic gaps. If there is a significant academic achievement disparity between urban and rural students, it will indicate that the online learning system may be more beneficial in urban settings. It may be due to higher digital literacy and easier accessibility to online learning technologies combined with the Internet and modern educational infrastructure. However, if these two groups perform equally well academically, then perhaps it shows that Internet education can be effective in both the city and the countryside. If that is the case, it may show that online education can be successful not only in cities but also in remote areas where Internet services or other resources are scarce. Therefore, assessment of academic achievement is a must in the appraisal of online learning within China's vocational education system.

Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS), version 26.0. The responses related to the factors of accessibility and effectiveness in online learning were subjected to analysis

using descriptive statistics. There is simply a broad summary of the survey results provided by these numbers. In the present survey, a total of five response options were documented, employing a rating scale ranging from 5 (indicating strong disagreement) to 1 (indicating strong agreement). Subsequently, inferential statistics were utilised to assess and contrast the accessibility and efficacy of online learning in urban and rural areas. The mean ratings of perceived accessibility and efficacy between urban and rural respondents were compared using independent samples of the Mann–Whitney U test due to its skewed distributions. The present study employed an independent sample t-test to examine the relationship between specific variables related to accessibility and effectiveness factors in the context of online learning. These variables included internet availability, device availability, digital literacy, infrastructure investment, learning management system (LMS) integration, assessment and feedback mechanisms, student engagement, and student satisfaction. A p-value below .05 established the chosen significance threshold. The skewed distributions of the students' academic scores also require the use of an independent Mann–Whitney U test to compare.

The research was conducted according to strict ethical guidelines. Everyone who participated in the study was sent an online questionnaire. They also received a participant information sheet and consent form at that time. All participants were carefully informed of the voluntary nature of their participation and assured that they may withdraw from research at any time without consequences. All subjects in the study provided online consent and were able to get contact information for questions or clarification. The preservation of privacy and confidentiality for the participants will be guaranteed. All data were encrypted to protect the privacy of the participants.

3. Results

3.1 Demographics variables

The population sample was 50% rural (N = 157), comprised of 85 (54%) males and 72 (46%) females, and 50% urban (N = 157), comprised of 88 (56%) males and 69 (44%) females. Demographic results are presented in Table 1. The mean age and duration of vocational education exhibit distinct differences between the rural and urban populations. Specifically, the rural population has a slightly higher mean age (24.96 years) than the urban population (24.42 years). Similarly, the mean duration of vocational education differs between the two groups, with 1.65 years for rural participants and 2.18 years for urban participants.

Table 1. Demographics of participants

	Rural Population N = 157	Urban Population N = 157
Male	54%	46%
Females	56%	44%
Age	24.96 ± 3.52 ^a	24.42 ± 2.20 ^a
Vocational Education Duration	1.65 ± 1.14 ^a	3.18 ± 1.03 ^b

[Similar superscript indicates no significant difference in mean value ($p > 0.05$), whereas different superscript indicates the existence of significant differences in mean value ($p < 0.05$)]

3.2. Accessibility of Online Learning

In terms of the accessibility of online learning, six key dimensions are investigated: internet availability, device availability, digital literacy, infrastructure investment, learning management system (LMS) integration, and assessment and feedback mechanisms. It became evident that rural areas are at a considerable disadvantage, as depicted in Fig 1. For instance, vocational students from rural areas show a significantly lower level ($p < 0.0001$) of internet availability (1.46 ± 0.36) compared to their urban counterparts (4.55 ± 0.36). Similarly, device availability in rural areas (1.51 ± 0.44) represents a significantly lower level ($p < 0.0001$) than its urban counterpart (4.49 ± 0.40).

Moreover, digital literacy among rural vocational students (1.62 ± 0.47) is significantly lower than ($p < 0.0001$) in urban areas (4.51 ± 0.39). The data also reveals a significant difference ($p < 0.0001$) in infrastructure investment, with rural regions (2.23 ± 0.58) significantly trailing urban areas (4.53 ± 0.33). Furthermore, when considering Learning Management System (LMS) integration, rural vocational students (1.61 ± 0.44) face a significant gap compared to urban vocational students (4.42 ± 0.45) ($p < 0.0001$), suggesting that the seamless incorporation of online learning tools is less prevalent in rural areas. Additionally, rural students' access to assessment and feedback mechanisms (1.59 ± 0.38) is again significantly lower than urban students (4.47 ± 0.36) ($p < 0.0001$).

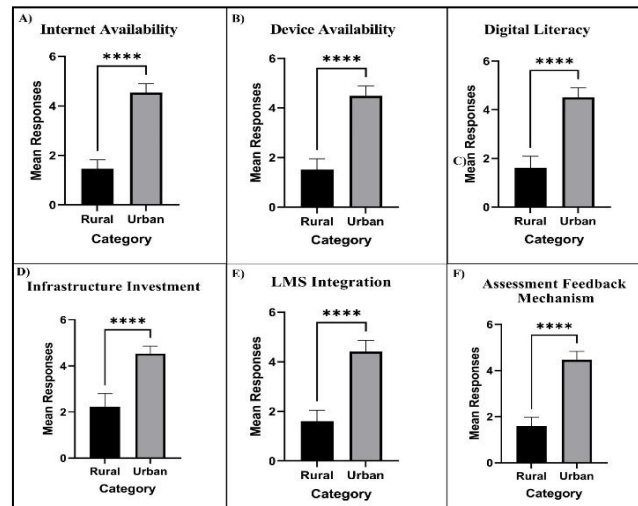


Fig 1: The difference in the accessibility of online learning in six parameters between rural and urban vocational students. A) Internet Availability, B) Device Availability, C) Digital Literacy, D) Infrastructure Investment, E) LMS Integration, F) Assessment Feedback Mechanism (**** indicates $p < 0.0001$).

3.3. Effectiveness of Online Learning

Regarding the effectiveness of online learning, two dimensions are considered: student engagement and student satisfaction (Fig 2). Similar to the findings on accessibility, the urban population displayed considerably higher levels of effectiveness in online learning, as depicted in Table 3. Rural students report significantly lower levels of engagement (1.54 ± 0.42) compared to urban students (4.47 ± 0.37), a substantial gap underscored by a highly significant p-value ($p < 0.0001$). Similarly, rural vocational students express lower levels of satisfaction (1.55 ± 0.41) compared to urban populations (4.41 ± 0.33), with a significant difference ($p < 0.0001$) in their perceptions of online education.

Effectiveness of online learning has also been supported by the significant gap in academic performance represented in Fig 2. Rural students (63.45 ± 7.28) perform considerably worse academically than their urban counterparts (82.70 ± 6.82), with a highly significant p-value ($p < 0.0001$).

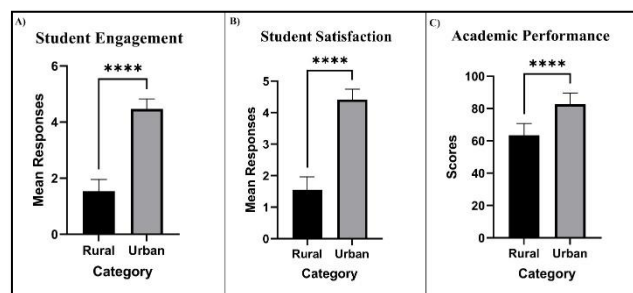


Fig 2: The difference in the effectiveness of online learning in three parameters between rural and urban vocational students. A) Student Engagement, B) Student Satisfaction, C) Academic performance (**** indicates $p < 0.0001$).

3.4. Correlation among all variables

The Pearson Correlation coefficients, significant at the 0.01 level, unveil robust associations across multiple variables related to online learning (Fig 3). In this context, internet availability exhibited substantial positive correlations with variables such as device availability ($r = 0.954, p < 0.0001$), digital literacy ($r = 0.947, p < 0.0001$), LMS integration ($r = 0.940, p < 0.0001$), assessment and feedback mechanisms ($r = 0.944, p < 0.0001$), student engagement ($r = 0.946, p < 0.0001$), and student satisfaction ($r = 0.947, p < 0.0001$) and infrastructure investment ($r = 0.901, p < 0.0001$), among others. Similarly, device availability had strong correlations with digital literacy ($r = 0.948, p < 0.0001$), infrastructure investment ($r = 0.899, p < 0.0001$), LMS integration ($r = 0.941, p < 0.0001$), assessment and feedback mechanisms ($r = 0.940, p < 0.0001$), student engagement ($r = 0.947, p < 0.0001$), and student satisfaction ($r = 0.944, p < 0.0001$).

Moreover, infrastructure investment displays strong positive correlations with LMS Integration ($r = 0.908, p < 0.0001$), assessment and feedback mechanisms ($r = 0.911, p < 0.0001$), student engagement ($r = 0.896, p < 0.0001$), and student satisfaction ($r = 0.898, p < 0.0001$). Additionally, LMS integration reveals robust positive correlations with assessment and feedback mechanisms ($r = 0.941, p < 0.0001$), student engagement ($r = 0.937, p < 0.0001$), and student satisfaction ($r = 0.934, p < 0.0001$). Furthermore, assessment and feedback mechanisms exhibit significant positive correlations with student engagement ($r = 0.949, p < 0.0001$) and student satisfaction ($r = 0.949, p < 0.0001$). Finally, a notably strong positive correlation exists between student engagement and student satisfaction ($r = 0.953, p < 0.0001$).

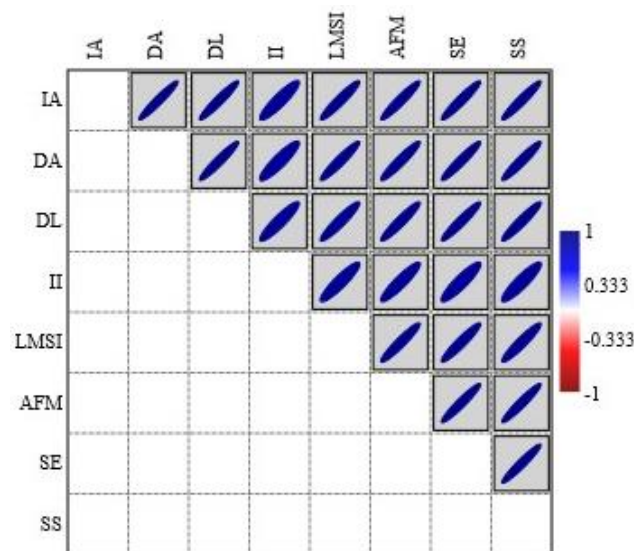


Fig 3: Correlation among overall parameters of accessibility of online learning and effectiveness of online learning among all students. [IA = Internet Availability, DA = Device Availability, DL = Digital Literacy, II = Infrastructure Investment, LMSI = Learning Management System (LMS) Integration, AFM = Assessment and Feedback Mechanisms, SE = Student Engagement, SS = Student Satisfaction] ($p < 0.05$ are boxed).

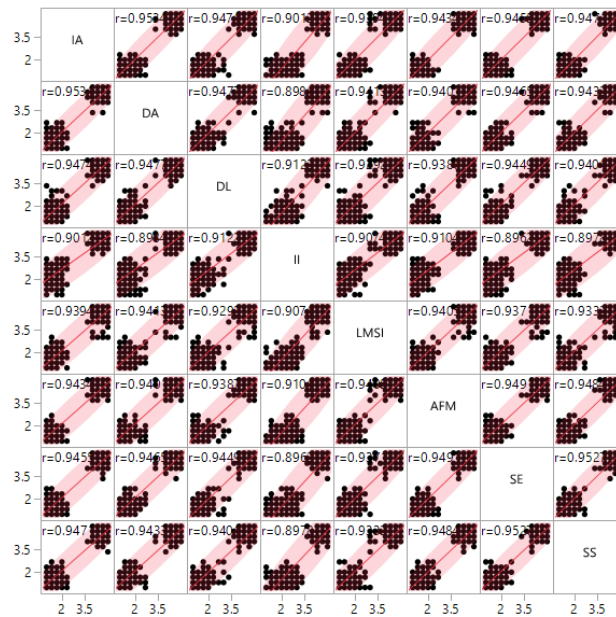


Fig 4: Scatterplot matrix among overall parameters of accessibility of online learning and effectiveness of online learning among all students. [IA = Internet Availability, DA = Device Availability, DL = Digital Literacy, II = Infrastructure Investment, LMSI = Learning Management System (LMS) Integration, AFM = Assessment and Feedback Mechanisms, SE = Student Engagement, SS = Student Satisfaction].

A principal component analysis (PCA) plot was generated to explore the interrelationships among various accessibility and effectiveness variables in online learning. This analysis was further supported by a correlation matrix plot (Figure 5). The PCA's measured parameters were differentiated in the ordination plots based on the first (94.43%) and second (1.245%) principal components.

The angles observed between the vectors in the PCA plot illustrate the relationships between these characteristics. In the context of PCA, angles of less than 90 degrees between two vectors indicate a positive correlation between the variables they represent [41]. In the study, all eight variables (namely, Internet Availability, Device Availability, Digital Literacy, Infrastructure Investment, Learning Management System (LMS) Integration, Assessment and Feedback Mechanisms, Student Engagement, and Student Satisfaction) exhibited angles of less than 90 degrees. It signifies a strong positive correlation among these variables (Fig 4).

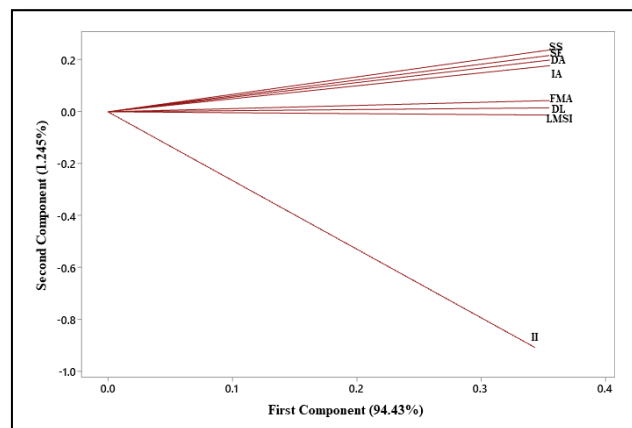


Fig 5: Ordination plot for eight variables [IA = Internet Availability, DA = Device Availability, DL = Digital Literacy, II = Infrastructure Investment, LMSI = Learning Management System (LMS) Integration, AFM = Assessment and Feedback Mechanisms, SE = Student Engagement, SS = Student Satisfaction].

4. Discussion

The study provides a comprehensive analysis of the accessibility and effectiveness of online learning in China's vocational education system, revealing considerable disparities between rural and urban areas. Demographically, the rural population in the sample had a slightly higher mean age than their urban counterparts. The longer mean duration of vocational education in urban settings could be linked to better accessibility and engagement with online education (Roslin et al., 2022). In a study, it has been found that vocational students prefer flexibility in time management, independent development, self-regulation, and self-directed education within the online learning system (Aydin et al., 2015). Thus, different advanced, flexible, and accessible options for online learning retain and engage more vocational students.

The current study also suggested that rural areas are at a marked disadvantage across multiple dimensions of accessibility, including internet availability, device availability, digital literacy, and infrastructure investment. Internet and device availability showed the most remarkable disparities, which have far-reaching implications for educational equality between urban and rural counterparts (Graves et al., 2021). These quantitative differences mean that the essential tools for online learning are themselves severely limited, making rural people all but disenfranchised in digital education (Graves et al., 2021; Reddick et al., 2020).

Studies recently undertaken by Dlamini and Vilakati (2021) and Das et al. (2021) indicated that there is a massive divide between accessible internet in rural areas. Limited access to reliable network connections is one of the biggest obstacles they have identified (Dlamini & Vilakati, 2021; Das, Sahoo & Pati, 2021). In addition, economic factors like the high price of internet access and equipment tend to make it difficult for most households in rural areas. These results not only corroborate the conclusions of the present study concerning internet and equipment access, but they also supply a more comprehensive perspective for comprehending those gaps in infrastructure. Further, Dube (2020) has pointed to the difficulties experienced by schools in remote areas that already suffer from poor connections.

Furthermore, the study points out that levels of digital literacy are significantly lower among rural students than in urban areas. This deficiency points to a disconcerting ill-preparedness for rural students stepping into the contemporary labour market at a time when digital competence has become almost as important as basic literacy (Wilson, Briere & Nahachewsky, 2015). On this issue, Ye and Yang (2020) put forward that the lack of prospects to participate in technological activities is a bottleneck hindering the development of technical skills (Ye & Yang, 2020). Lack of resources, teaching methods, and low digital literacy among teachers often lead to poor engagement (Du Plessis & Mestry, 2019; Soekamto et al., 2022). Thus, despite the existence of online learning possibilities on a technical level throughout rural areas in China, many students still lack the skills needed to take full advantage (Parkes et al., 2015).

This present research also sees a noticeable gap in the LMS integration assessment and feedback mechanisms. With regard to this aspect, Turnbull et al. (2021) pointed out that high-quality integration of the LMS paves the way for various educational purposes, such as disseminating electronic course content or improving teaching and learning activities (Turnbull, Chugh & Luck, 2021). The considerable LMS integration gap in settings that are mostly rural can be due both to a lack of efficacy and technical understanding on the part of students (Kusuma, 2022).

However, according to the findings of this study, students in urban areas enjoy a much stronger online learning environment. There is also enhanced network capability as well as the use of modern digital instruments. Since urban areas are often the centers for technological innovation, they likely have higher levels of high-speed internet and other modern amenities (Wang, 2013). This urban concentration of resources also holds for human capital, as teachers tend to be more likely exposed regularly to professional development concentrating on digital pedagogies and have better-developed digital literacy practices (Pratolo & Solikhati, 2021). It not only helps educators build up their own digital literacy, but it also creates an environment for the development of students' digital literacy (Mudra, 2020). Such greater access may contribute to a higher level of interaction and participation, furthering the educational gulf between the city and the countryside.

The findings of the study showed substantial disparities in the effectiveness of online learning, as measured by student engagement and satisfaction. Rural students reported considerably lower engagement and satisfaction levels than urban students. It suggests that rural students are less equipped to partake in online learning, and their experience is markedly less enriching (Leichty, 2021). Such gaps in engagement and satisfaction could have long-term consequences for academic performance and increase educational dropout rates (De la Varre et al., 2014). Our study also showed that rural students perform worse academically, underscoring the compound effect of these disadvantages.

Several probable reasons underlie these stark disparities. Existing literature attributes the digital divide primarily to infrastructural and economic issues and limited exposure to technology in rural settings (Belay, 2020). Moreover, perceived usability and effectiveness hinder the incorporation of state-of-the-art LMS platforms, which have been shown to be vital for effective online learning (Cavus, 2021).

Another significant aspect that emerged is the self-reinforcing nature of the benefits enjoyed by urban students. Technology-enhanced learning leads to more proficient use, which in turn results in higher student engagement and satisfaction (Serrano et al., 2019). Additionally, urban educational systems promote more teacher training focused on digital pedagogies so that they can manage LMS, further enhancing student outcomes (Aditya, 2021).

Furthermore, the study has shown the substantial academic performance gap between urban and rural students, which has significant implications for the effectiveness of online learning platforms. This study's findings have revealed that urban students' scores far outpace the rural students' average scores. This academic gap aligned with the current findings on lower engagement and satisfaction levels among rural students and presented compelling evidence of pronounced disparities in the effectiveness of online learning between urban and rural vocational students in China. Existing literature corroborates that both engagement and access to robust online learning environments are critical determinants of academic performance (Mandasari, 2020).

The strong Pearson correlation coefficients across multiple variables related to online learning indicate a holistic pattern of disadvantage for rural students. Furthermore, the Principal Component Analysis (PCA) further supports these findings, showing that all measured parameters—Internet Availability, Device Availability, Digital Literacy, Infrastructure Investment, LMS Integration, Assessment and Feedback Mechanisms, Student Engagement, and Student Satisfaction—have strong positive correlations with each other. This suggests that improving a single dimension could have a multiplier effect, potentially elevating other facets of online learning as well. It aligns with existing literature, which posits that educational systems, particularly those incorporating online elements, are complex and interrelated (Panigrahi, Srivastava & Sharma, 2018; Pandita & Kiran, 2023; Zimba, Khosa & Pillay, 2021). The implications here are manifold. Most critically, they offer a quantitative foundation for formulating targeted, multifaceted intervention strategies designed to bridge the urban-rural gap in online learning experiences (Aditya, 2021).

Thus, the current study offers a robust, multi-dimensional investigation into the disparities in online learning accessibility and effectiveness between urban and rural students in China's vocational education system. The study significantly extends the current understanding of the urban-rural digital divide by incorporating various measurable variables— from infrastructure and device availability to digital literacy and academic performance. While our study is extensive, it is not without limitations. It could be deepened further through future research employing qualitative methodologies such as focus groups and interviews. Furthermore, longitudinal research is required to evaluate the long-term effects of these gaps on career prospects and social mobility.

5. Conclusion

In summary, this study highlights the substantial difference in terms of access and effectiveness between urban and rural vocational students learning online. In every vital area, rural areas are habitually slower than their urban counterparts—everything becomes an issue from internet availability to device readiness, digital literacy, and facility with eLife technology or simply LMS. Even the way feedback is elicited differs somewhat between locations. The digital divide this implies is not just about getting hold of the tools but also about being able to use them effectively. Greater access to resources translates into higher levels of engagement, satisfaction, and grades

for urban students. Moreover, the strong interconnections hypothesized between all of the online learning parameters stress again that e-learning problems can only be addressed through a holistic approach.

Although the study makes many insightful observations, it suffers several limitations. The cross-sectional format makes it impossible to gauge potential long-range trends or the changing nature of such inequalities. As the focus was predominantly on vocational students, this might make it challenging to apply the findings more broadly in other educational sectors. Although necessary, other nuances more directly related to socio-economic development or culture, as well as those posed by simply geographical location, may not have been taken into consideration when it comes to subjective components like student satisfaction. In addition, given that the population of vocational students is so significant in China, it may raise questions about representativeness.

These are the findings of this study, sounding the need for further research. These differences could only be explained by longitudinal work showing how they change over time. It would provide an insight into possible mitigation approaches. The scope was broadened to take in other educational sectors to increase applicability. Further, understanding how local variables influence the online learning experience may delve into more subtle approaches to intervention. With the digital divide being a pressing concern, there is an inherent promise in exploring targeted strategies—be it in infrastructure augmentation or pedagogical shifts—to ensure that rural areas are not left in the digital shadows.

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