Measurement and Influencing Factors of the Second Digital Divide among University Students in Guangdong

Yumin Li, Menglin He, Zhen Zhang, and Erwei Wang*

Beijing Institute of Technology, Zhuhai campus, Zhuhai, Guangdong, China

Abstract. This study proposes a second digital divide measurement for university students in Guangdong, encompassing internet usage proficiency and internet-enabled learning levels. Drawing on information literacy theory, the dimensions of information awareness, acquisition, storage, retrieval, utilization, and ethical/security considerations are individually assessed. A total of 1038 valid responses were collected through a questionnaire survey, and data analysis was conducted using descriptive statistics and variance analysis. The internet usage and enabled learning levels of university students in Guangdong are found to be moderately above average. The second-level digital divide among university students in Guangdong is complex, resulting from the interactive effects of personal factors, growth environment, and university environment. Personal characteristics (gender, grade), growth environment (average living expenses, parental education, family location, growth location, family learning environment), and campus learning environment have a significant impact on both the level of internet usage and internet-enabled learning. Conversely, personal characteristics (disciplinary category), and school location exhibit no significant impact on internet-enabled learning levels.

1. Introduction

The National Telecommunications and Information Administration (NTIA) of the United States has been releasing the "Falling Through the Net" series of reports since 1995, focusing on the phenomenon of the digital divide. In their 1999 report, the NTIA defined the digital divide as the imbalance in the popularization and application of emerging information and communication technologies, with the internet as a representative. This sparked global scholarly interest in the digital divide, further highlighted by the Organization for Economic Co-operation and Development (OECD) with their 2001 report "Understanding the Digital Divide," bringing the issue into the global spotlight.

As of now, the understanding of the digital divide can be categorized into three levels. Initially, studies by the NTIA identified the digital divide as the disparity in Internet access, termed the "Access Gap", primarily focusing on the lack of information and communication technology or information poverty. As information technology evolved, and with the continuous improvement of information infrastructure and the proliferation of the Internet, the disparity in gradually narrowed. The digital divide thus evolved to signify differences in usage, termed the "Usage Gap," focusing on disparities in the level of digital technology usage represented by information and communication technologies[1]. The third level of the digital divide refers to the gap in information resources and knowledge acquisition and the resulting inequalities in Internet income, also known as the "Knowledge Gap"[2].

Contemporary university students, often referred to as the "Digital Native" generation, naturally align with digital technology and products. Research both domestic and international shows that there is virtually no difference in internet access among this generation. However, significant disparities still exist in their modes of access, frequency of use, and application scenarios, deeply influenced by their growth environment, making the second digital divide a particularly acute issue.

2. Literature review

In the realm of digital divide exploration, Van Dijk categorizes the "new digital divide" into four dimensions: psychological motivation, physical access, digital skills, and usage behavior[3]. The digital skills dimension is further delineated into six abilities: basic operations of information technology, understanding structure, information search, external communication, content creation, and goal achievement.

Regarding the measurement and influencing factors of the digital divide among university students, Wang Sufang, et al have developed a digital divide measurement index, including internet usage ability and internet learning index. They explored the influencing factors from three aspects: personal characteristics, social structure, and internal psychological emotions. Their findings indicate that the impact of social structure factors on the second digital divide among contemporary
university students has weakened, with internal psychological emotions and knowledge and learning abilities being more critical[4]. Guo Jiao, et al designed a digital divide measurement index encompassing three dimensions: network access, usage behavior, and mental engagement. Based on the data of 64,949 undergraduates from 39 universities in Shanghai, their research revealed that the "old digital divide" is nearing closure, while the "new digital divide" becomes more pronounced. First-generation college students from families showed significantly lower concentration and persistence in online learning compared to their non-first-generation counterparts, with rural students facing more severe challenges than urban students. Network access has a minimal impact on undergraduate students' self-assessment of online learning effectiveness, whereas usage preferences and engagement levels significantly influence it[5]. Zhao Lianfei's research suggests that the first digital divide is influenced by factors such as the location of life before attending university, family income level and parents' educational level. The second divide is directly affected by factors like internet age and campus environment, and the third by the campus environment and daily internet usage duration[6]. Srinuan and Bohlin[7] have identified that the group differences in the digital divide, in addition to common classification standards such as gender, age, education, income, and urban-rural divide, also include experience, ability, and psychological factors. Lian Yadi, et al have elucidated four levels of the digital divide among university students, using capital as a tool to interpret the causes of the digital divide among university students and proposing paths to bridge it, including establishing a supply guarantee for information technology infrastructure, cultivating standardized digital usage values, building heterogeneous information technology skill learning communities, and fostering good information technology usage habits[8].

This paper focuses on university students in Guangdong Province, designing measurement indicators to explore the level of their second digital divide and analyzing the influencing factors from three perspectives: personal characteristics, growth environment, and university environment.

3. Research methodology and process

3.1. Dependent and independent variables and operationalization

For university students, the second digital divide primarily manifests in internet usage skills and content, especially in the context of learning applications. Therefore, we propose two measurement indicators as dependent variables: "Internet Usage Ability" and "Internet-Enabled Learning Level".

In the contemporary era of widespread internet usage, information literacy serves as a comprehensive reflection of an individual's internet usage abilities. Drawing from relevant studies on information literacy, the measurement of "Internet Usage Ability" for university students includes six dimensions: information awareness, information acquisition, information storage, information retrieval, information utilization, and information ethics and security. Each dimension is assessed through Likert-scale questions in the questionnaire, such as, "When conducting online searches, can you clearly express your intentions using keywords? " Scored from 1 to 5, with higher scores indicating higher ability levels." The relevant scores contribute to the overall score in the dimension of information retrieval ability. Given the balanced requirements of information literacy across various dimensions, equal weighting is assigned to each dimension.

Based on information literacy theory, the "Internet-Enabled Learning Level" is measured across the same six dimensions, with equal weighting assigned to each.

Regarding independent variables, we have identified 11 variables, including gender, academic year, field of study, location of the university, family location, upbringing location, average monthly living expenses, parental education level, family learning environment, and campus learning environment.

3.2. Formulation of research hypotheses

Based on the analysis in Part 2, our study examines the impact of individual characteristics, growth environment, and university environment features on the second digital divide.

Firstly, individual characteristics may influence university students' internet usage level and the level of internet-enabled learning.

Hypothesis 1a and 1b: There is a significant difference in internet usage ability and internet-enabled learning level among university students of different genders.

Hypothesis 2a and 2b: There is a significant difference in internet usage ability and internet-enabled learning level among university students of different academic years.

Hypothesis 3a and 3b: There is a significant difference in internet usage ability and internet-enabled learning level among university students of different fields of study.

Secondly, social structural factors may impact the second digital divide.

Hypothesis 4a and 4b: There is a significant difference in internet usage ability and internet-enabled learning level among university students with different average monthly living expenses.

Hypothesis 5a and 5b: There is a significant difference in internet usage ability and internet-enabled learning level among university students with different parental education levels.

Hypothesis 6a and 6b: There is a significant difference in internet usage ability and internet-enabled learning level among university students from different family locations.

Hypothesis 7a and 7b: There is a significant difference in internet usage ability and internet-enabled
learning level among university students from different places of upbringing.

Hypothesis 8a and 8b: There is a significant difference in internet usage ability and internet-enabled learning level among university students with different home learning environments.

Thirdly, the university learning environments may also affect the extent of internet usage among university students.

Hypothesis 9a and 9b: There is a significant difference in internet usage ability and internet-enabled learning level among university students based on the location of their university.

Hypothesis 10a and 10b: There is a significant difference in internet usage ability and internet-enabled learning level among university students with different campus learning environments.

3.3. Questionnaire design and data collection

In building upon relevant research, we developed a survey questionnaire, which was revised after a preliminary small-scale pre-survey. The official questionnaire comprises three parts: (1) Personal and environmental characteristics, consisting of nine single-choice and one multiple-choice questions; (2) The level of internet usage among university students, covering six aspects: information awareness, information acquisition, information storage, information retrieval, information utilization, and information ethics and safety, for which twenty-five five-point Likert scale questions are set; (3) The level of internet-enabled learning among university students, also divided into six aspects similar to the previous section, with twelve five-point Likert scale questions.

The distribution of the questionnaire was conducted through an online survey. From January to March 2023, it was disseminated via social media platforms such as WeChat, resulting in the collection of 1038 valid responses. The respondents were from universities across various cities in Guangdong Province, as shown in Table 1 below.

<table>
<thead>
<tr>
<th>Personal Characteristics</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>430</td>
<td>41.40%</td>
</tr>
<tr>
<td>Female</td>
<td>608</td>
<td>58.60%</td>
</tr>
<tr>
<td>Grade Level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshman</td>
<td>262</td>
<td>25.20%</td>
</tr>
<tr>
<td>Sophomore</td>
<td>308</td>
<td>29.70%</td>
</tr>
<tr>
<td>Junior</td>
<td>352</td>
<td>33.90%</td>
</tr>
<tr>
<td>Senior</td>
<td>100</td>
<td>9.60%</td>
</tr>
<tr>
<td>Field of Study</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural sciences</td>
<td>118</td>
<td>11.40%</td>
</tr>
<tr>
<td>Social Science</td>
<td>508</td>
<td>48.90%</td>
</tr>
<tr>
<td>Engineering Science</td>
<td>232</td>
<td>22.40%</td>
</tr>
<tr>
<td>Medical Science</td>
<td>42</td>
<td>4.00%</td>
</tr>
<tr>
<td>Humanities</td>
<td>138</td>
<td>13.30%</td>
</tr>
<tr>
<td>Family's Location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside Guangdong Province</td>
<td>94</td>
<td>9.10%</td>
</tr>
<tr>
<td>Pearl River Delta Region</td>
<td>430</td>
<td>41.40%</td>
</tr>
</tbody>
</table>

The reliability and validity of the questionnaire were tested using SPSS 21. The overall scale demonstrated a high level of reliability, with a Cronbach's Alpha coefficient of 0.949. The validity of the questionnaire, assessed through the Kaiser-Meyer-Olkin (KMO) measure, yielded a value of 0.944, indicating good construct validity.

4. Result

4.1. Level of internet usage

The results indicate that the surveyed participants achieved an average score of 3.84 on the overall internet usage level, which is above the medium level, with a standard deviation of 0.59, pointing to relatively large individual differences. Examining the specific
dimensions, scores were higher in aspects such as internet information acquisition, internet information retrieval and internet information ethics and safety, nearing 4 points. However, scores were comparatively lower in dimensions like information awareness and internet information storage. This suggests that while university students are proficient in using the internet, they exhibit a lesser ability in the cognition and understanding of internet information resources. They are less capable of effectively mining and storing useful information, indicating a need for further enhancement in information awareness and information storage skills.

4.2. Level of internet-enabled learning

The results reveal that the overall score for the level of internet-enabled learning among the surveyed students is 3.65, which is above the medium level but slightly lower than their usage level. In various dimensions, the scores are higher in aspects such as information retrieval and ethics and safety in internet-enabled learning, nearing 4 points. However, scores are relatively lower in dimensions like information awareness, acquisition, storage, and utilization in internet-enabled learning, particularly in information storage and utilization, which barely meet the passing level. This indicates that while university students are generally capable of utilizing the internet for learning purposes, there is room for improvement in the efficiency and effectiveness of their use of online resources.

5. Analysis of influencing factors

In this study, single-factor analysis of variance and F-tests were employed to analyze the influencing factors of the second digital divide among university students. The results are presented in Table 2.

### Table 2. The results of analysis of variance

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Internet Usage Level</th>
<th>Internet-Enabled Learning Level</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a and 1b</td>
<td>F Value 4.953 0.026 F Value 1.075 0.300</td>
<td>Accept 1a, Reject 1b</td>
<td></td>
</tr>
<tr>
<td>2a and 2b</td>
<td>F Value 2.990 0.019 F Value 5.173 0.000</td>
<td>Accept 2a, Reject 2b</td>
<td></td>
</tr>
<tr>
<td>3a and 3b</td>
<td>F Value 2.798 0.025 F Value 1.281 0.275</td>
<td>Accept 3a, Reject 3b</td>
<td></td>
</tr>
<tr>
<td>4a and 4b</td>
<td>F Value 10.14 0.000 F Value 6.073 0.000</td>
<td>Accept 4a, Reject 4b</td>
<td></td>
</tr>
<tr>
<td>5a and 5b</td>
<td>F Value 21.54 0.000 F Value 30.27 0.000</td>
<td>Accept 5a, Reject 5b</td>
<td></td>
</tr>
<tr>
<td>6a and 6b</td>
<td>F Value 3.576 0.007 F Value 2.063 0.084</td>
<td>Accept 6a, Reject 6b</td>
<td></td>
</tr>
<tr>
<td>7a and 7b</td>
<td>F Value 48.56 0.000 F Value 25.73 0.000</td>
<td>Accept 7a, Reject 7b</td>
<td></td>
</tr>
<tr>
<td>8a and 8b</td>
<td>F Value 14.48 0.000 F Value 11.61 0.000</td>
<td>Accept 8a, Reject 8b</td>
<td></td>
</tr>
<tr>
<td>9a and 9b</td>
<td>F Value 1.105 0.346 F Value 0.897 0.442</td>
<td>Reject 9a, 9b</td>
<td></td>
</tr>
<tr>
<td>10a and 10b</td>
<td>F Value 23.24 0.000 F Value 20.40 0.000</td>
<td>Accept 10a, 10b</td>
<td></td>
</tr>
</tbody>
</table>

### 5.1. Personal characteristics

The study found significant gender differences in the level of internet usage among university students, with males (M=3.89) having a significantly higher level of internet usage than females (M=3.81). This difference was most pronounced in dimensions of information acquisition (Male M=4.02; Female M=3.90) and information ethics and safety (Male M=4.06; Female M=3.93). In contrast, the gender differences in the level of internet-enabled learning were not significant, although there were significant gender influences on the dimensions of information awareness and information storage. Males scored higher in information awareness (M=3.75) compared to females (M=3.60), but lower in information storage (Male M=3.412; Female M=3.564), suggesting that while males may find and understand learning information on the internet more easily, their information storage ability is weaker than that of females.

There were also significant differences in internet usage and internet-enabled learning levels among students of different academic years. Freshmen notably differed from students in other academic years and postgraduate students in terms of internet usage level. For internet-enabled learning level, significant differences were found between lower and higher undergraduate years, as well as between undergraduate and postgraduate levels.

There were significant differences in the level of internet usage among students of different academic disciplines, but no significant differences in the level of internet-enabled learning.

### 5.2. Environmental factors of upbringing

Students with different average monthly living expenses exhibited significant differences in both internet usage and internet-enabled learning levels.

There were significant differences in both internet usage and internet-enabled learning levels among students with parents of varying educational levels. A further analysis revealed that higher parental education levels correlated with higher student levels in both internet usage and internet-enabled learning, especially for students whose parents had at least a bachelor's degree or equivalent.

Students from different family locations showed significant differences in internet usage levels. Significant differences were observed between the Pearl River Delta region and the Eastern Coastal region of Guangdong (Average Difference=0.094; P=0.021<0.05), Western region (Average Difference=0.256; P<0.05), Northern mountainous region (Average Difference=0.149; P=0.009<0.05), and between the Eastern Coastal and Western regions (Average Difference=0.162; P=0.025<0.05). However, family location had no impact on the level of internet-enabled learning.

Significant differences were also found in both internet usage and internet-enabled learning levels among students from urban versus rural upbringing areas. Students raised in urban areas (M=3.94, M=3.71) scored
higher in both internet usage and internet-enabled learning levels compared to those from rural areas (M=3.69, M=3.54).

Differences in the home learning environment also significantly affected both internet usage and internet-enabled learning levels among students.

5.3. University environments

There were no significant differences in internet usage and internet-enabled learning levels among students from universities located in different regions. However, significant differences were found in both internet usage and internet-enabled learning levels among students from different campus learning environments.

6. Conclusions and discussion

Based on the theory of information literacy, this study proposes using the levels of internet usage and internet-enabled learning to measure the second digital divide among university students. This approach has a more solid theoretical foundation compared to previous studies and offers a more scientific and reasonable design of measurement indicators and dimensions. By analyzing the impact of personal characteristics, growth environment, and university environment, this study provides a more comprehensive overview than previous research, which often focused on single aspects such as social structure or individual skills. It aligns more closely with the realities of the current information society. The study finds that personal characteristics such as gender, academic year, and field of study significantly influence the level of internet usage, while growth environment factors like parental education level, family location, place of upbringing, and home learning environment significantly affect both internet usage and internet-enabled learning levels. Specifically, students with higher parental education levels, from families in the Pearl River Delta region, raised in urban areas, and with better home learning environments, show significantly higher internet usage levels compared to their counterparts.

Firstly, the pre-university growth environment remains an important factor influencing the second digital divide among university students in Guangdong. Factors such as parental education level, family location, urban or rural upbringing, and the home learning environment impact students' internet usage levels[9]. Enhancing young people's internet usage and enabled learning levels is crucial in bridging the digital divide.

Secondly, post-entry into university, factors like individual knowledge, learning abilities, and university environment play a significant role. As students advance in their academic years, both their knowledge and internet usage and enabled learning levels increase. Differences in fields of study lead to natural variations in computer and internet skills. The disparity in knowledge and skills across different disciplines deepens the divide in internet usage and enabled learning levels among university students. Furthermore, the transition from high school to university, with its significant changes in living and learning patterns and the differences in time management skills, especially in balancing study and entertainment, further widen the gap in internet-enabled learning levels. Therefore, university education for the digital native generation should focus on cultivating information awareness and enhancing information utilization skills, developing mature digital mindsets, and applying various internet-based information skills more effectively in their field of study.

This study has certain limitations, including sample size, the richness of university environment variables, and the application of big data in learning behavior, which can be addressed in future research.

Acknowledgement

This study was supported by the 2021 Higher Education Research Project of the 14th Five Year Plan of the Guangdong Higher Education Association (No. 21GYB111), Guangdong Province Key Research Base of Humanities and Social Sciences (Grant No. 2022WZJD012).

References
