JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY
Vol. 18, No. 3 (2022), pp. 96-110

# Using Rasch model analysis for assessing psychometric properties of digital citizenship in Indonesian students

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*(submitted: 14/5/2022; accepted: 14/12/2022; published: 31/12/2022)*

**Abstract**

In the networked society era, more research on students' digital citizenship levels has been conducted and reported. However, rarely is this topic covered from third-world countries, which have seen significant increases in the numbers of Internet users. Seeking to examine digital citizenship levels in Indonesian students, this study employed the non-experimental quantitative research design with an online questionnaire distributed to a total of 581 students. The data collected were analyzed using Rasch Model measurement and Winsteps 5.1.2 software. Descriptive statistical analysis was utilized to evaluate students' digital literacy readiness in terms of knowledge and understanding in accessing technology and the Internet, while Differential Item Functioning (DIF) was utilized to identify digital citizenship levels based on demographic profile. The findings showed that students had high levels of readiness in relation to Internet skills, Internet attitudes, computer self-efficacy, and three digital citizenship sub-scales. More in-depth analysis indicated the presence of differences in students' digital citizenship levels by gender, parents' education level, and Internet use frequency. It is hoped that this research will expand literature concerning digital citizenship as a reference for future research works and for policymakers, particularly in developing countries.

**KEYWORDS:** Digital Citizenship, Internet Skills, Internet Attitude, Computer Self-Efficacy, Rasch Model.

**DOI**
https://doi.org/10.20368/1971-8829/1135684

**CITE AS**
Prasetiyo, W.H., Sari, B.I., Patmisari, Sa'diyah, H., Naidu, N.B.M., & Prasetyo, E. (2022). Using Rasch model analysis for assessing psychometric properties of digital citizenship in Indonesian students. *Journal of e-Learning and Knowledge Society*, 18(3), 96-110.
https://doi.org/10.20368/1971-8829/1135684

## 1. Introduction

Over a few decades, technological developments have been significantly driving changes in human life. For instance, the Internet has made it easy for users to access information, deliver criticisms, and make decisions (Anderson et al., 2008; Qazi et al., 2014; Waheed et al., 2016). In the educational field, the Internet has revolutionized learning environments through integration of technology and information, which has transformed interactions and approaches between teacher and student, be it offline, online, or blended. The Internet and computer skills proficiency are needed as a basic competency, which constitutes a standard parameter impactful to students' academic achievements (Losh, 2003; Nketiah-Amponsah et al., 2017; Qazi et al., 2021).

Nonetheless, scholars have paid attention to gaps in access and technology use between males and females (Ardies et al., 2014; Mumporeze & Prieler, 2017; Potvin & Hasni, 2014). Literature shows that this divergence is

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attributable to the goal of improving students' learning outcomes (Lee et al., 2019; Siddiq & Scherer, 2019; Tam et al., 2020). Other than demographic factors, the technology use gap is also created by computer use frequency, computer anxiety, computer self-efficacy, and Internet skills (Cai et al., 2017; Harrison & Rainer, 1992; Rahiem, 2020). Even though Internet use within educational settings or in personal life has been on the rise (Ribble & Miller, 2013), notably for building social networks (Lenhart et al. 2011), it still demands knowledge and skills related to how to participate and engage according to digital citizenship criteria (Alvermann et al., 2012). Some attributes of well-informed digital citizens are then conceptualized, including social media use for sharing knowledge with others, communicating with relatives and old friends, making new friends, and participating in political agendas online (Choi, 2016; Isman & Gungoren, 2014; Payne, 2016).

Meanwhile, technology and Internet use calls for action from users, especially the adolescent among them, to anticipate and minimize the negative effects of social network use, including privacy, cyberbullying, and information accuracy/reliability issues (Choi, 2016). (Livingstone et al., 2011) pointed out the risk of using the Internet and technology which can lead to a variety of problems and at the same time raise concerns among society, such as online harassment and intimidation, privacy issues, and the ability to evaluate online content and to use information according to copyright rules. In the same vein, (Lenhart et al., 2011) mentioned the need for knowledge and understanding about digital citizenship in an attempt to deal with technology abuse and misuse. Besides, overuse of the Internet such as in the cases of plagiarism, illegal content access, and screen addiction effect on physical and mental health remain a persisting concern for many (Al-Abdullatif & Gameil, 2020; Aldosari et al., 2020; Cahyono, 2016).

Digital citizenship is a multidisciplinary and complex concept that is debated. The term has been discussed in a variety of contexts related to the impact of new technology on the human being (Choi, 2015). In 2010, Common Sense Education and Harvard Graduate School of Education established the Digital Literacy and Citizenship Curriculum, which defines digital citizenship as "the responsible use of technology to learn, create, and participate" (James et al., 2019). Mossberger et al. (2007) defines digital citizenship as economic and political engagement. Digital citizenship protects adolescents from cybercrime and cyberbullying, according to (Lenhart et al., 2011). A set of skills that incorporates digital citizenship would help people think critically and make ethical decisions about what they see, say, and share online (Collier, 2009).

This study investigated the relationship between psychometric properties like Internet attitudes, Internet skills, and computer self-efficacy and digital citizenship level in a group of students based on some demographic aspects, namely gender, Internet use frequency, and parents' education level. Some studies have shown the role or the effect of three variables on digital citizenship level (Beam et al., 2018; Ke & Xu, 2018; Prasetiyo et al., 2021), but there is a lack of influential studies from developing countries that capture digital citizenship development. Indonesia is home to an immense number of Internet users and rapidly developing e-market, which can serve as a benchmark for the discourse of digital citizenship development within the larger scope (APJII, 2020; Arifin, 2017). The research questions guiding this study are therefore as follows:

*RQ1*. How ready are students in using Internet technology in schools?

*RQ2*. Do significant differences exist in students' digital citizenship levels based on gender, Internet use frequency, and parents' education level?

## 2. Materials and Method

### 2.1 Instrumentation

This research developed digital citizenship parameters in reference to the framework developed by Ribble (2015), called the nine elements of digital citizenship, which consists of the sub-scales respect, educate, and protect (REP). The measurement scales employed in this research were adopted from multiple measurement instruments developed by Jones and Mitchell (2016) and Al-Zahrani (2015). The digital citizenship scale (DCS) by Al-Zahrani (2015) was based on the assumption of Ribble (2015). The digital citizenship measurement scale (DCS) was a 15-item 5-point Likert scale (5 = strongly agree, 1 = strongly disagree) consisting of sub-scale respect (6 items), educated (5 items), and protect (4 items). The question items for the variables Internet attitudes (5 questions) and computer self-efficacy (5 questions) were based on the measurement scale of Al-Zahrani (2015), and 9 question items for the variable Internet skills referred to the opinion of van Deursen et al. (2016). Additionally, Jones & Mitchell (2016) also developed a DCS based on respectful online behavior and online civic engagement practice, with a total of 11 question items on a 5-point Likert scale from 'not everyone likes me' to 'everyone likes me very much'. In this research, the measurement scale preferred was the same as the DCS developed by Al-Zahrani (2015).

### 2.2 Respondents

This study recruited 581 students from 12 senior high schools across Central Java, Indonesia, by convenience sampling technique. A tix box on an online consent form was used for under-age participants to discuss with their parents the item content in order for them to understand the process, risk, and benefits of the research and to gain consent from their parents to participate in the research. The survey was also conducted with the consent and voluntary support of school principals and teachers. The online survey was taken anonymously to ensure the confidentiality of the participants' personal data.

## 2.3 Data Collection and Analysis

The raw data collected were inputted in a Microsoft Excel file and later evaluated with Rasch Model analysis using Winsteps 5.1.2 software. Afterward, we analyzed the instrument validity and reliability and tested the person and item fit on a simultaneous basis. The validity of the instrument in this research was judged from the validity of the responses to the items, in which case 0.5 < acceptable Outfit Mean-Square (MNSQ) < 1.5, -2.0 < acceptable Outfit Z-Standard (ZSTD) < +2.0, and 0.4 < acceptable Point Measure Correlation (Pt Mean Corr) < 0.85 (Sumintono & Widhiarso, 2014).

We found a respondent who gave outlier responses (at maximum rank). Therefore, data cleaning was conducted to figure out respondents' consistency in answering and to figure out whether there was no aberrance in answers (Widhiarso & Sumintono, 2016). The results showed that no respondents were found to give answers aberring or differing from other respondents' response pattern; hence, all students' responses could be analyzed and no data were excluded. The demographic profiles of the students are provided in Table 1.

| Characteristics | Students % (n = 581) |
|---|---|
| Demographic | |
| Sex | |
| Male | 25% (144) |
| Female | 75% (437) |
| Age | |
| 16-17 | 93% (542) |
| 18-19 | 7% (39) |
| Parent Education Level | |
| Elementary School | 13% (74) |
| Junior High School | 17% (100) |
| Senior High School | 42% (245) |
| Bachelor | 23% (135) |
| Master | 4% (24) |
| Doctoral | 1% (3) |
| Length of Internet Usage in a Day (in Hours) | |
| 1-3 (Low) | 3% (17) |
| 4-6 (Medium Low) | 26% (150) |
| 7-9 (Medium High) | 37% (214) |
| > 9 (High) | 34% (200) |
| Digital Devices Frequently Use | |
| Handphone | 99% (576) |
| Laptop | 0.7% (4) |
| PC Dekstop | 5% (31) |
| Tablet | 0,3% (1) |
| Internet Budged per Month | |
| IDR10.000-25.000 | 8% (48) |
| IDR26.000-50.000 | 25% (144) |
| IDR51.000-75.000 | 37% (214) |
| > IDR75.000 | 30% (175) |
| *IDR = Indonesian Rupiah | |

**Table 1** - Demographic and socioeconomic characteristics.

## 2.4 Instrument Validity and Reliability

This study used Winsteps 5.1.2 to perform calibration of item difficulty level and person ability. This selection of Winsteps software was grounded on its ability to convert the scores of the items measured on a Likert's scale and ordinal data based on the frequencies at which responses occurred as a probability into an interval scale called logit (log unit) via an algorithmic function. This enabled us to predict individuals' responses accurately on all items according to the measurement model, that is, by using person parameter and item parameter on the same scale (as a measure of difficulty level). This serves as a key indicator in Rasch model analysis (Boone et al., 2014; Sumintono & Widhiarso, 2014, 2015; Wirth et al., 2016).

Two-side (person and item) measurement scale/Wright map model was implemented to gain an idea about 34 students' digital citizenship level measurement items and 581 respondents. The items were centered on zero, allowing students to 'float' and enabling calibration of students' digital citizenship levels. Table 2 presents the instrument's internal reliability score. This score refers to the statistical fit or reliability index reported in logit measure, which determines the quality of all dimensions of the digital citizenship and psychometric properties measurement instrument.

The person reliability index (0.85) (see Table 2) indicates that the consistency of students' responses was 'good' (Sumintono & Widhiarso, 2014). The same interpretation logic also applied to the item reliability index (1.00), which was categorized as 'extraordinary' (Sumintono & Widhiarso, 2014). This shows that the item reliability and person reliability were 'exceptionally good'. The Cronbach's Alpha coefficient (0.89) (see Table 2), according to Rasch model calculation, depicts that the interaction between 581 students and 34 items was 'extremely good'. This score shows that there was a high level of interaction between person and item. An instrument that has internal psychometric properties with 'extremely good' consistency is considered as a highly reliable instrument (Bond & Fox, 2007). Therefore, the Internet attitudes, Internet skills, computer self-efficacy, and digital citizenship instrument with REP sub-scales are considered as an instrument that is reliable to use across various respondent groups. Besides, the unidimensionality measure was good, as shown in the Raw Variance Explained by Measure score of 42.3%, or, in other words, the raw variance index was beyond the standard 40% (Fisher, 2007). This means that the instrument was effective at measuring students' digital citizenship levels. The effectiveness of the instrument can also be seen from the person and item instrument score, which approached 1.0. This is supported by the chi-square score significance level that indicates that the data fit the model (Boone et al., 2014; Engelhard, 2013).

We subsequently analyzed the person separation index to estimate how well the digital citizenship instrument was able to discriminate 'person ability' against the latent variable. The higher the separation index, the more reliable the probability would be for the respondents to respond to the item correctly. On the other hand, the item separation index shows how broadly the item is defined as 'easy' and 'difficult'. The wider the distribution, the better the fit, which is supposed to be equal or exceed three (Boone et al., 2014; Fisher, 2007). Based on Table 2, the person separation index (2.42) and the item separation index (14.29) show that the reliability of the digital citizenship instrument was distributed among various respondents and items. This criterion supports the digital citizenship level measurement instrument, including the model fit and reliability of the instrument in identifying students' digital citizenship levels.

Based on the explanation above, the selection of data analysis by Rasch model was considered appropriate as it aimed to measure latent properties in assessing human perceptions and attitudes. Rasch model analysis was able to elaborate on item difficulty levels using the right measurement (item calibration) as well as by detecting item fit and measuring respondents' knowledge levels (Bond & Fox, 2007; Engelhard, 2013; Linarce, 2012). Furthermore, respondent analysis with this measurement model yielded better, more accurate results, which supported respondents' consistency against the questionnaire (person fit statistics). An algorithmic function was used to result in measurement with the same interval scale. In addition, calibration of the measurement model and conjoint measurement process was aimed at figuring out the relationship between item difficulty and person ability with the same unit scale (logit).

Winsteps 5.1.2 was used to test students' digital citizenship levels and specifically assess the levels based on gender using descriptive statistics (mean and standard deviation), item score (logit), and person score (logit). Therefore, if the person logit was positive, then the student's perceived digital citizenship level was higher than the item mean. By contrast, if the person logit was negative, then the student's perceived digital citizenship level was lower than the mean score required for the item tested. In conclusion, logit scores reflect students' digital citizenship levels.

| Psychometric Properties | Person | Item |
|---|---|---|
| *N* | 581 | 34 |
| *Outfit mean square* | 1.03 | 1.04 |
| Mean | 1.13 | 0.00 |
| SD | 0.69 | 0.81 |
| Separation | 2.42 | 14.39 |
| Reliability | 0.85 | 1.00 |
| Alpha Cronbach | 0.89 | |
| Chi-square ($\boldsymbol{x}^2$) | 43383.9544** | |
| Raw Variance Explain by Measure | 42.3% | |
| *Note*: ** $P < 0.01$ | | |

**Table 2** - Summary statistics of person and items.

## 3. Results

### 3.1 Students' readiness (knowledge and understanding) in using and taking advantage of Internet technology

Based on Table 3, the person mean measure (logit) was found to be +1.13 logit, with SD = +0.69 or greater than 0 logit. This shows that students had good knowledge and understanding in using and taking advantage of technology and the Internet as digital citizens. Table 4 provides that of the six dimensions measuring students' readiness in using technology and the Internet, students scored highest in the Internet attitudes dimension, with a mean score of 3.06, SD = 2.04, and lowest in the protect sub-scale, with a mean score of 0.93, SD = 1.4According to Table 3, the person mean measure (logit) of +1.13 was useful in measuring students' readiness in using technology and the Internet, with a standard deviation of 0.69. This score shows that the distribution of students' readiness in terms of knowledge and understanding was rather wide. An item mean measure (logit) of 0.00, with standard deviation of 0.81 (see Table 3), demonstrates a wide item difficulty level distribution of the whole item score (logit) based on logit scale on item difficulty level.

Table 5 shows the classification of items by item difficulty level or instrument item score (logit) of the students' digital citizenship questionnaire. The items classification into four difficulty levels was performed by distributing item logit scores by mean and standard deviation. There were 6 items (17.65%) in the 'very difficult' category (LVI > 0.81 logit), 11 items (32.35%) in the 'difficult' category (+0.81 LVI 0.00 logit), 6 items (17.6%) in the 'easy' category (0.00 LVI -0.81 logit), and 11 items (32.35%) in the 'very easy' category (LVI < -0.81 logit) based on students' judgment. Overall, students judged the Internet attitudes dimension to be within the 'easy' category and 2 of 5 items in the computer self-efficacy dimension to be within the 'very difficult' and 'difficult' categories. As for the Internet skills dimension and REP sub-scales, the items were more evenly distributed from the 'very difficult' category to the 'very easy' category.

Based on Figure 1, item difficulty levels could also be seen from the item-person Wright-map from the 'very easy to agree with' for the respondents category on the bottom right side of the map (CSE item -0.81 logit score)

| **Descriptive Statistics** | **Person** | **Item** |
|---|---|---|
| *N* | 581 | 34 |
| *Measure* | | |
| Mean | 1.13 | 0.00 |
| SD | 0.69 | 0.81 |
| Standard Error | 0.03 | 0.14 |

**Table 3** - Results of student's digital citizenship.

| **Construct** | **Mean** | **Std. Deviation** |
|---|---|---|
| *Internet Skills* | 1.04 | 0.75 |
| *Internet Attitudes* | 3.06 | 2.04 |
| *Computer Self Efficacy* | 1.01 | 2.32 |
| *Digital Citizenship* (Sub-Scale): | | |
| *Respect* | 2.29 | 1.56 |
| *Educates* | 1.54 | 1.43 |
| *Protects* | 0.93 | 1.43 |

**Table 4** - Results of student readiness in the using of internet.

| **Difficulty Level Distribution** | | | | |
|---|---|---|---|---|
| **Construct** | **Very difficult** | **Difficult** | **Easy** | **Very easy** |
| *Internet Skills* | IS6, IS5 | IS2 | IS4, IS9, IS1 | IS3, IS8 |
| *Internet Attitudes* | | | IA2, IA4, IA1, IA3, IA5 | |
| *Computer Self Efficacy* | CSE5, CSE3 | CSE4, CSE2, CSE1 | | |
| *Digital Citizenship* (Sub-Scale) | | | | |
| *Respects* | | R1 | R2, R5 | R4, R6, R3 |
| *Educates* | E3 | E5, E2 | E4 | E1 |
| *Protects* | P1 | P3, P2, P4 | | |

**Table 5** - Calibrate the linkage of digital citizenship items.

to the 'very difficult to agree with' for the respondents category on the upper right side of the map (R1 item +0.81 logit score). Besides, the items in the instrument functioned well and were able to separate respondents' digital citizenship levels, with unidimensionality raw variance index of 42.3% as can be seen in Table 2.

In item difficulty level distribution, the 'very difficult to agree with' and 'difficult to agree with' categories were found in items spread across almost all dimensions. Based on Figure 1, the 'very difficult to agree with' category included items IS5, CSE5, CSE3, E3, and P1, whereas the 'difficult to agree with' category included items IS2, CSE4, CSE2, CSE2, P3, P2, and P4. This shows that items within the 'very difficult to agree with' category, such as E2, E5, R1, and IS2, described that students had had knowledge and understanding in using and taking advantage of the Internet well. However, their knowledge and abilities to use and maintain their personal computers were still low. In addition, the item difficulty level distribution in the 'difficult to agree with' category also indicates that students' awareness of security protection within the digital world was still very low. The 'easy to agree with' item difficulty level was distributed in items IS4, IS9, IS1, IA1, IA3, IA2, IA4, IA5, R2, R5, and E4, whereas the 'very easy to agree with' category was spread in items IS3, IS8, R4, R6, R3, and E1 (see Figure 1). The two item distribution categories above show that students had had knowledge and understanding in using and taking advantage of technology and the Internet very well and had had rather good awareness in behaving and carrying out activities using the Internet well.

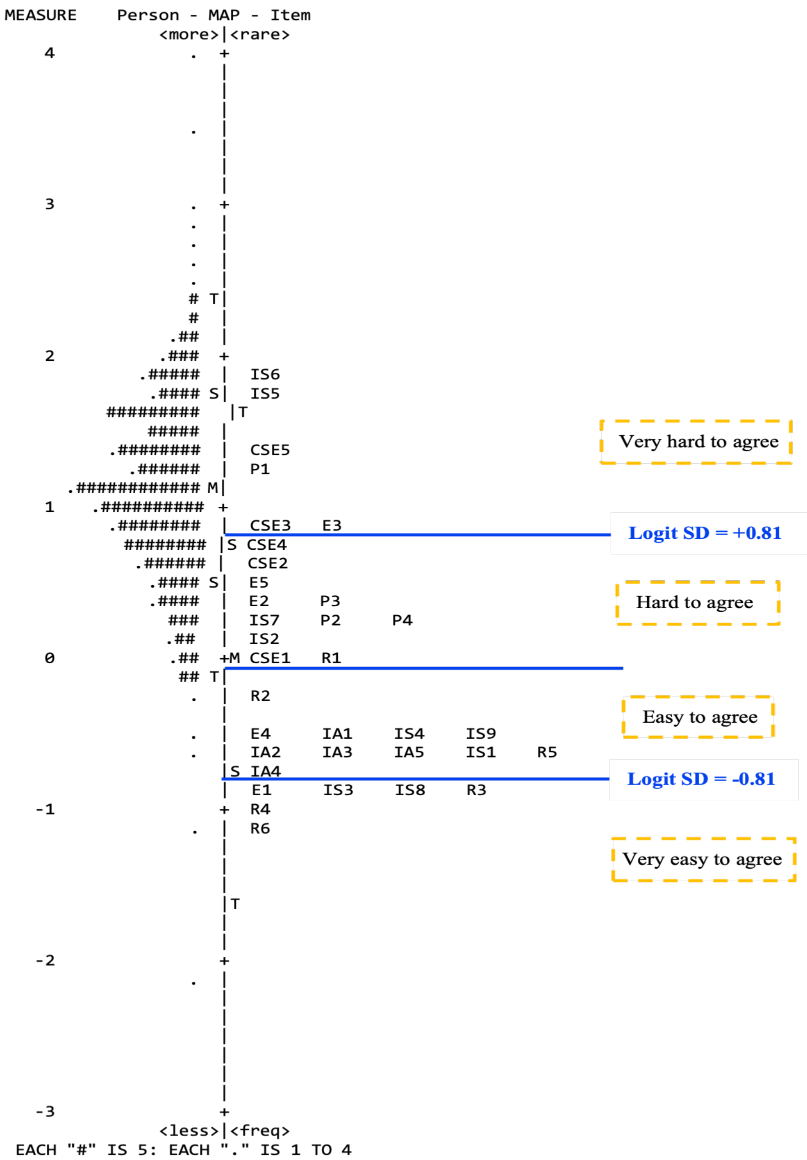


**Figure 1** - Rasch Wright Item-Person Map of Digital Citizenship.

### 3.2 Digital Citizenship Level Difference between Demographic Factors and Students' Readiness in Digital Citizenship Improvement

In the next stage, the differences raised by gender, parents' education level, and Internet use frequency and students' readiness in terms of knowledge and understanding as well as technology and Internet access which influenced digital citizenship levels were analyzed with Differential Item Functioning (DIF). The analysis for each of the three demographic factors abovementioned is explained below.

Figure 2 provides DIF analysis based on respondents' gender. There were 20 items identified as showing significant differences, namely IS1, IS2, IS3, IS5, IS6, IS9, IA4, CSE2, CSE4, CSE3, CSE5, R1, R2, R3, R4, R6, E1, E2, P3, and P4. From items IS1, IS3, and IS9 it was known that female students were better able to use computer, the Internet, and smartphone than their male counterparts. In addition, items IS5 and IS6 show that many of the male students experienced difficulties in accessing the Internet. Nonetheless, as shown in item IA4, they perceived benefits from the use of the Internet to a greater degree than their female equivalents. On the other hand, from items CSE2, CSE3, CSE4, and CSE5, it was indicated that female students had a higher level of confidence in accessing computer. Items R2, R3, R4, and R6 show that more male students demonstrated awareness of and appreciation for the code of ethics for using and accessing computer and the Internet than female students. Item R1, however, shows that female students had a higher level of awareness, particularly concerning the knowledge that spreading computer viruses is a form of digital crime.

From items E1 and E2 it was discovered that male students' awareness in learning and pursuing understanding of the use and utilization of technology and the Internet was higher. It was as supported by male students' opinions on item P4, showing that their awareness in protecting their personal privacy when accessing technology and the Internet surpassed their female counterparts. Meanwhile, item P3 portrays that female student had a higher degree of awareness in preventing digital crime via antivirus installation.

Other than the results of DIF analysis, the difference in students' digital citizenship levels could also be identified from the gender-based person-item Wright map (see Figure 3). It is shown that female and male students had nearly identical digital citizenship levels within the 'high' and 'low' categories, but more than half were within the former. Figure 3 provides person score distribution from students' digital citizenship levels categorization as seen from the person-item Wright map that illustrates students' digital citizenship levels distribution based on gender from the 'strong' category to the 'moderate' and 'weak' categories. Figure 3 also presents person (female and male) distribution within the 'weak' category on the bottom right side on the map with logit score < +0.69 to the 'strong' category on the upper right side of the map with logit score > +1.13.

Figure 4, meanwhile, shows students' digital citizenship levels based on parents' educational background. A total of 24 items demonstrated significant differences, namely IS2, IS3, IS4, IS5, IS6, IS7, IA3, IA4, IA5, CSE1, CSE2, CSE3, CSE4, CSE5, R3, R6, E1, E3, E4, E5, P1, P2, P3, and P4. It is worth noting that the variety of students' parents' education levels presented highly significant differences in digital citizenship levels. For one, items R6, IS3, and IA3 indicate that students whose parents were with a Master's degree scored lower than students whose parents had latest education at the elementary school, junior high school, senior high school, Bachelor's, and Doctoral levels. Similarly, items E1, E5, E4, P3, and P4 show that students with parents whose latest education was at the Doctoral level had a higher degree of awareness that informed them on the protect sub-scale than students with parents of lower educational levels.

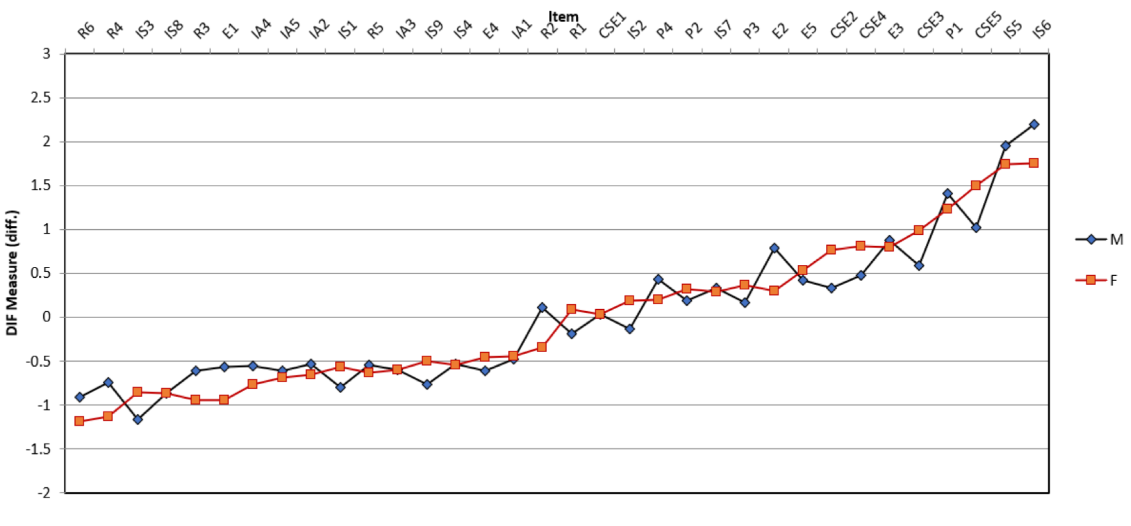


**Figure 2** - Person DIF plot based on Gender (M : Male; F : Female).


**Figure 3** - Rasch Wright Person Logit Map of Digital Citizenship based on Gender.

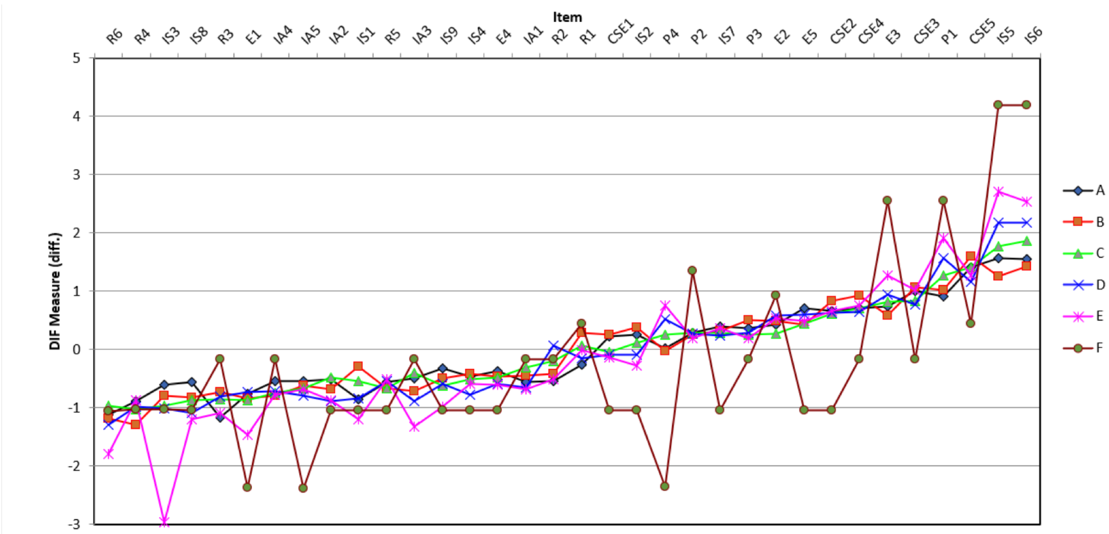


**Figure 4** - DIF Parents' educational background (A : Elementary School, B : Junior High School, C : Senior High School, D : Bachelor, E : Master, F : Doctor).


**Figure 5** - Rasch Wright Person Logit Map of Digital Citizenship based on parents' education level.

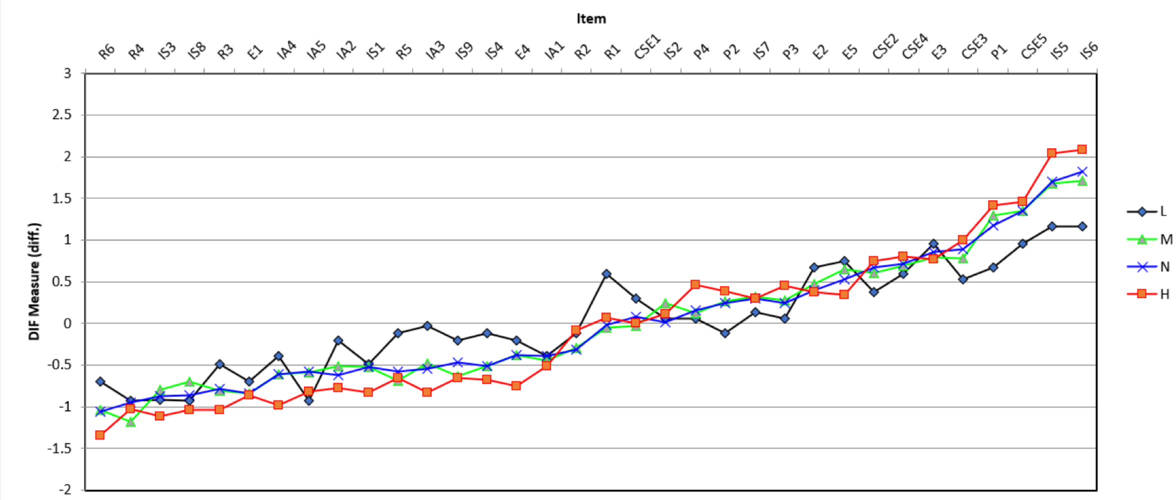


**Figure 6** - DIF Frekuensi Using Internet (L : Low, M : Medium Low, N : Medium High, H : High).

Items IS4, CSE1, IS2, IS7, CSE2, CSE3, CSE4, and CSE5 also suggest that students with parents of Doctoral education level had low levels of self-confidence and knowledge. However, items R3, IA4, P2, E3, and P1 show that these students had higher levels of awareness of protection, security, and code of ethics. It was also discovered based on items IS5 and IS6 that these students were lacking in the knowledge aspect in using the Internet as an information medium in comparison to other groups of students.

The DIF analysis results described above are relevant with the distribution of students' responses to each item, as can be seen in Figure 5. Various levels of students' digital citizenship can be seen in the person-item Wright map based on parents' education level, according to which the 'strong' digital citizenship level was demonstrated mostly by students whose parents were of senior high school and Bachelor's education levels.

According to Figure 6, there were 18 items showing significant differences based on Internet use frequency per day. Students with 'low' Internet use intensity, as shown in items R6, IA4, IA2, IA3, E2, E5, IS9, E4, and CSE1, perceived more benefits from use of technology, computer, and the Internet. Besides, items R3, R5, IS4, and R1 show that students of the 'low' category were more aware of self-protection online than students of other categories. However, in terms of knowledge and understanding of self-protection such as on the Internet use code of ethics, students with 'medium-high' intensity scored high in awareness, as shown by items P4, P2, and P1. Interestingly, students with 'high intensity' felt it to be more difficult to access the Internet, as shown by items IS5 and IS6, than those with 'low', 'medium-low', and 'medium-high' Internet use intensities. Data also suggest that students of the 'high' intensity group scored lowest in the access and use of smartphone and felt less benefits from Internet use in their daily lives.

Additionally, the person score distribution from students' digital citizenship levels categorization can be seen from the person-item Wright map. Based on Figure 7, the distribution of students' digital citizenship levels according to Internet use frequency per twenty-four hours presents three categories, 'strong', 'moderate', and 'weak', in which case the person distribution in the 'weak' category is presented on the bottom right side of the map, with logit score < +0.69, and the person distribution in the 'strong' category is presented on the upper right side of the map, with logit score > +1.13. The distribution of the majority responses in the 'strong' and 'moderate' categories from students with 'medium-high' and 'high' Internet use frequencies can also be seen.

## 4. Discussion

This research sought to figure out to what extent students' digital citizenship levels differed in terms of gender, parents' education level, and Internet use frequency. Findings show that there were differences in readiness in terms of knowledge and understanding between male and female students to use information technologies, such as computer, smartphone, and the Internet, in daily activities, including educational, online commercial, and social media activities. This is in line with the results of several previous studies, which explained that female students had a more limited access to technology than male students, but most of them had more positive perceptions on ICT tools utilization (Mumporeze & Prieler, 2017; Tam et al., 2020).
DIF analysis (see Figure 2 and Figure 3) shows that various demographic variables had an effect on students' digital citizenship levels. Gender-wise, male and female students both had high/strong digital citizenship levels, but mostly the former was higher/stronger than the latter.

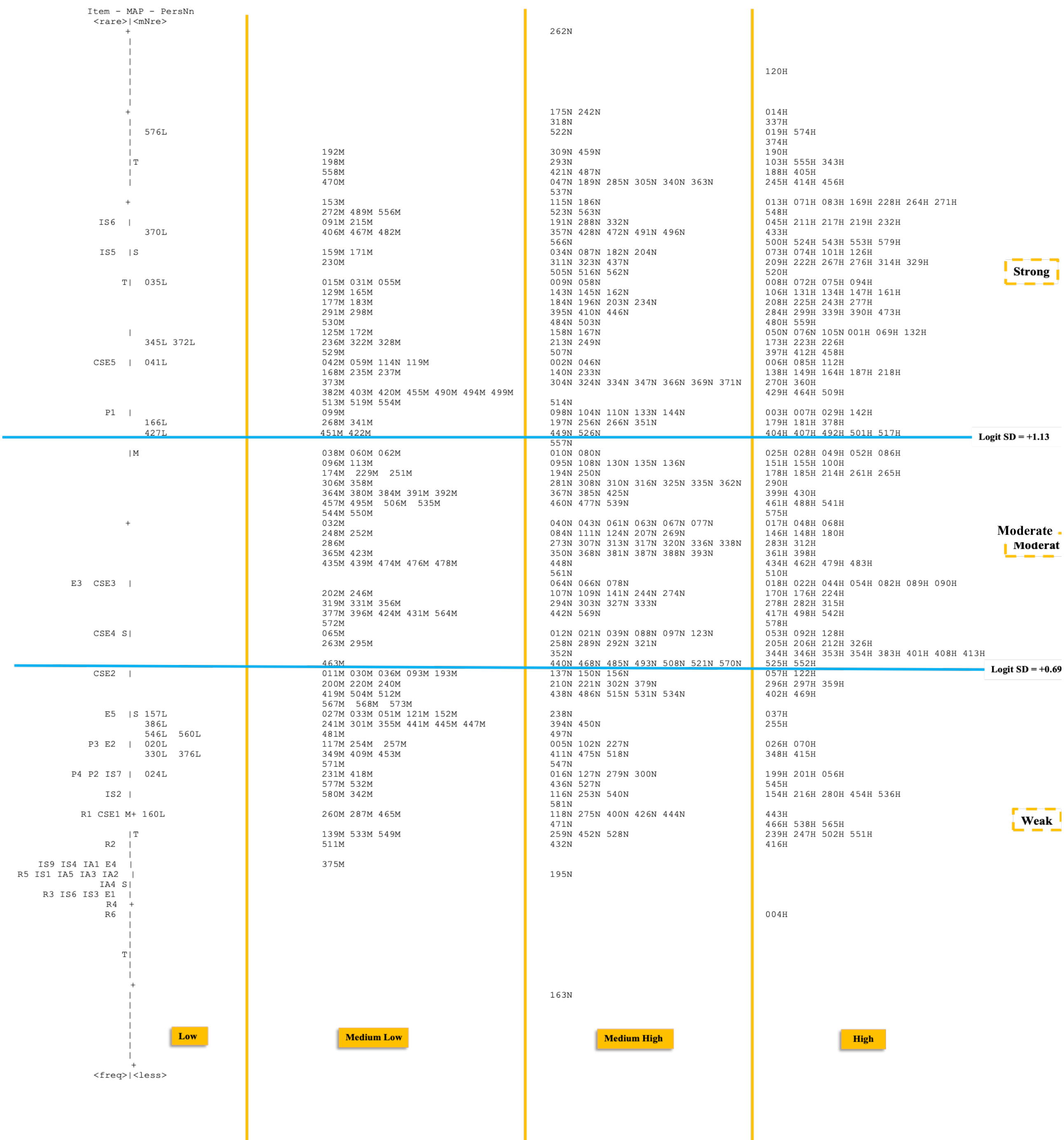

**Figure 7** - Rasch Wright Person Logit Map of Digital Citizenship based on parents' education level.

A study by Babu et al. (2016) explained that male students were more comfortable in using and accessing technology and the Internet than their female equivalents.

Furthermore, we found that, in terms of Internet use, students had some difficulties, including in understanding computer components terminology for the purpose of periodically maintaining personal computer or installing necessary applications like an antivirus, among others. In addition, students' awareness of online protective steps, such as periodically changing password and preventing personal data theft, was considered as very low. Nevertheless, they exhibited awareness in Internet use as a means of purchasing certain things keeping in mind the code of ethics according to the online commerce mechanism (Anandhita & Ariansyah, 2018; Jokisch et al., 2020; Oldeweme et al., 2021; Rahiem, 2020).

The results of DIF analysis in this research as well as Wright map show that male students outperformed female students in digital citizenship level. The digital citizenship construct describes students' readiness as digital citizens in terms of knowledge and understanding in using computer and the Internet according to ethics, values, norms, and rules for communicating and interacting in online environments. Some studies have put an emphasis on reinforcement of concepts and meanings of digital citizens on attitudes and behaviors in online environments, such as taking responsibility for all behaviors conducted in online environments, including interacting and communicating with others via online media (Ribble, 2015; Simsek et al., 2013).

With regard to parents' education level, the data analysis findings demonstrate that students' parents' educational background did not affect their knowledge and understanding in using and accessing Internet technology, but it did on their awareness of self-protection and conducting activities over the Internet according to the ethics prevailing in online environment. According to (Shao et al., 2022), parents' education level had a negative moderating effect in relation to support for online learning implementation. As for the Internet use frequency aspect, we discovered that students with 'low' intensity enjoyed benefits, ease, and awareness of online privacy protection more than students with 'medium-low', 'medium-high', and 'high' intensities.

The results of our study provided insights on the necessity of integrating students' digital proficiency into their own instructional practices. As an example, the ubiquitous learning space allows children to develop to paradigm shift from the traditional method to a more personalized and interactive strategy for creating meaningful activities. According to (Keppel, 2014), digital citizenship promotes the development of self-regulated and constructivist learning processes, empowering students to expand their knowledge, skills, and behaviors. There is no doubt that adequate and appropriate training may assist students in enhancing their digital abilities and attitudes concerning technology use (Schmid & Petko, 2019).

## 5. Conclusion

The findings of this study reveal that the digital citizenship level of most Indonesian students is high. This means that they are ready to become digital citizens who are able to use and access technology and the internet appropriately. The results of the DIF analysis show that there are differences in the level of digital citizenship based on several aspects of student demographics, namely gender, parental education level, and the frequency of daily internet use. Another finding revealed that students' readiness in using and accessing technology and the Internet and students' level of digital citizenship were included in the 'strong' category. We pointed out that embedding instructional strategies into the curriculum and closing the digital ownership gap among Indonesian students are priorities to be addressed.

However, this research is not without limitations. First, this study was only concentrated on senior high school students within a limited areal scope. Therefore, future research is hoped to target respondents of other education levels in greater respondent concentrations. Second, this research was convened to the cross-sectional quantitative research design. Hopefully, future research may involve samples in greater sizes to ensure that the data collected are more varied and generalizable. Referring to the findings of this research, effective and specific strategies are required to improve students' digital citizenship levels by developing dimensions that influence and are able to improve students' digital citizenship with a higher degree of complexity, both in terms of knowledge and skills, in order to support their digital citizenship levels. From this research we concluded that developing a digital class culture is critical to improving students' digital citizenship levels (Pertiwi & Sutama, 2020). Applying technology-rich design in learning can serve as a catalyst for technological adaptation, including in accelerating the shift from face-to-face learning to online learning, from traditional methods to blended approach and game-based education (Jayanti et al., 2021; Mustofa & Riyanti, 2019; Wahyu et al., 2019).

## Acknowledgements

We would like to thank all the students who participated in this study. This research was supported by a grant from Universitas Muhammadiyah Surakarta. Code: 215/A.3-III/FKIP/III/2022.

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