Art. #2562, 10 pages, https://doi.org/10.15700/saje.v44n4a2562

Digital literacy and online learning satisfaction among junior high school students: A moderated mediation model

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To explore the mechanism among digital literacy, online learning satisfaction, online learning engagement, and parents' educational expectations, a survey-based quantitative research approach was adopted to collect data. A total of 916 Chinese junior high school students completed an online questionnaire that included the digital literacy scale, online learning engagement scale, perceived parental expectation (PPE) scale, and satisfaction with online learning scale. The analysis of the moderated mediation model revealed several key findings: (1) digital literacy had a positive correlation with online learning engagement and online learning satisfaction; (2) online learning engagement mediated the relationship between digital literacy and online learning satisfaction; (3) parents' educational expectations moderated the first half path (i.e., the association between digital literacy and online learning engagement) of the mediating effect. In other words, the relationship between digital literacy and online learning satisfaction could be characterised as a moderated mediated model. More measures should be taken to improve junior high school students' digital literacy and express parents' educational expectations appropriately to promote the quality of online learning.

Keywords: digital literacy; online learning engagement; online learning satisfaction; parents' educational expectations

Introduction

Online teaching has gradually been integrated into face-to-face teaching, and blended learning has become the new normal (Xiaoqi, Xiaowei, Shusheng & Mei, 2023). Especially during the lockdown of Coronavirus disease (COVID-19), most schools around the world have adopted electronic learning (E-learning) systems to continue teaching and learning (Weeden & Cornwell, 2020; Yu, 2022). The experience of COVID-19 shows that the future can be unpredictable and we need to continue to use digital learning platforms and tools to mitigate teaching and learning challenges (Scott, 2023). In this context, it is important to explore the factors underlying the online learning (Wei & Chou, 2020).

Literature Review

Digital literacy and online learning satisfaction

Digital technology plays a significant role in the economy, government, and education for Generation Z (Flavin, 2017). Digital literacy is one of the key indicators for measuring digital technologies at the individual and organisational levels (Gilster, 1997). According to the Working Group on Education on Digital Skills and Work (United Nations Educational, Scientific and Cultural Organization [UNESCO]), digital literacy includes information literacy, computer literacy, information and communication technologies (ICTs) literacy, and media literacy, which is the ability to obtain, understand, manage, integrate, evaluate, communicate, and create information securely and appropriately through digital technologies (Law, Woo, De la Torre & Wong, 2018). There is a gap in digital literacy between developed and underdeveloped countries, and between urban and rural areas, and to change this situation, different countries have adopted different strategies to enhance digital literacy. Effective use of digital technology has been found to improve students' knowledge, skills, attitudes, and emotions (Fadda, Salis & Vivanet, 2022; Koh, 2022; Nogueira, Teixeira, De Lima, Moreira, De Oliveira, Pedrosa, De Queiroz & Jeronimo, 2022; Ojo & Adu, 2018).

Online learning satisfaction means a feeling or attitude of whether learners' wishes and needs can be satisfied in online learning activities or processes, which is a significant indicator to measure the quality of online learning (Though, 1982). Scholars have explored and summarised various factors influencing the college

students' online learning satisfaction, which can be roughly divided into learner factors, teacher factors, learning content factors, learning media factors, environmental condition factors, learning media factors (Sun, Tsai, Finger, Chen & Yeh, 2008), and interactions (Alqurashi, 2019). Among learner factors, the time of using technology (Arbaugh, 2000), the degree of control over technology, the frequency of using technology (Piccoli, Ahmad & Ives, 2001), and the level of information system use (Chiu, Chiu & Chang, 2007; Younas, Noor, Zhou, Menhas & Qingyu, 2022) significantly affect the online learning satisfaction. These results suggest that students' digital literacy is closely related to online learning satisfaction. Before the COVID-19 pandemic, the research on online learning satisfaction focused on the higher education stage (Zhang, S, Chen, Cao, Wang, Wang & Qi, 2020). With the implementation of the epidemic response policy of "Suspending Classes Without Stopping Learning" in China, the online learning satisfaction of junior high school students has also come into the researchers' field of vision. However, there are quantitative and qualitative differences between middle school and college student populations in terms of digital literacy as well as self-control. Do the factors that affect college students' online learning satisfaction also apply to junior high school education? This is a question worth discussing.

Online learning engagement as a mediator

Online learning engagement is a kind of positive state of learners participating in online learning activities (Fredricks, Blumenfeld & Paris, 2004). The transformation into online learning from face-to-face teaching necessitates revisiting students' engagement and the role of learner characteristics (Kara, 2022). The application of Web-based learning technologies has a positive relationship with student engagement (Chen, Lambert & Guidry, 2010). The evidence suggests that the digital literacy of the students is a learner characteristic that has a positive relationship with online learning engagement (Getenet, Cantle, Redmond & Albion, 2024; Getenet, Haeusler, Redmond, Cantle & Crouch, 2024). Online learning engagement has been proven to be highly correlated with learning satisfaction (Ariani, 2015; Guo & Hu, 2021; Wefald & Downey, 2009). It seems that digital literacy is not only related to online learning satisfaction directly, but also indirectly related to online learning satisfaction via online learning engagement.

Parents' educational expectations as a moderator

Parents' educational expectations refer to parents' expectations about the level of education that children eventually receive (Benner & Mistry, 2007; Jodl, Michael, Malanchuk, Eccles & Sameroff, 2001). The famous Rosenthal effect suggests that when people feel positive expectations from significant others around them, they will also actively develop in the direction of significant others' expectations, and eventually act like their expectations. Ma and Wei (2017) construct a Rosenthal effect cycle model of parents' educational expectations model which points out that when children receive intellectual and emotional support and feel their parents' expectations, they change their learning motivation, attribution style, behaviours and attitudes, and other aspects to the direction of parents' expectations. Parents with higher educational expectations will spend more time and energy to participate in their children's learning. Parents who are highly concerned about children's studies can quickly identify their academic problems and communicate with teachers in time (Adelabu & Mncube, 2023). From this, we can infer that parents' educational expectations are a protective factor for online learning engagement, and digital literacy is another protective factor for online learning engagement. The protective factor-protective model in the field of adolescent development believes that different protective factors interact in predicting adolescent development (Fergus & Zimmerman, 2005). For junior high school students with high parents' educational expectations, they are more likely to fulfil their parents' expectations or needs (Wang, LF & Heppner, 2002). Therefore, digital literacy such as information acquisition, use, and sharing ability is fully utilised to invest in online learning, that is, high parental education expectations enhance the connection between digital literacy and online learning engagement. For the students with low parents' educational expectations, the promotion effect is not as obvious as that of junior high school students with high parents' educational expectations, because they may be engaged in non-academic activities such as online chatting and entertainment due to lower parents' educational expectations during the online learning process.

Conceptual Framework

Bandura's triadic reciprocality determinism focuses on the interaction among human's internal factors, behaviour and environment, with the three being mutually causal (Bandura, 1986). Digital literacy, online learning engagement, online learning satisfaction, and parents' educational expectations can be classified into these three aspects. Through literature review, we also discovered a close connection: digital literacy impacts online learning satisfaction via online learning engagement, and parents' educational expectations appear to strengthen this indirect relationship. Mediation and moderation are important methodological concepts

in social science research and important ways for researchers to explore the relationship between multiple variables (Fang, J, Zhang, Gu & Liang, 2014). Mediating effect represents the mechanism that independent variable influences dependent variable through intermediary variable (Miočević, O'Rourke, MacKinnon & Brown, 2018). When the influence of one variable on the other variable hinges on the level of a third variable, the third variable plays a moderating role between them (Cohen, Cohen, West & Aiken, 2003). In other words, parents' educational expectations seem to have a moderating process on the mediating effect of online learning engagement.

Based on the above review of literature and the conceptual framework, we proposed three hypotheses:

H_1: Digital literacy of junior high school students would be correlated with online learning satisfaction positively.

H_2: Online learning engagement would mediate the relationship between digital literacy and online learning satisfaction.

H_3: The effect of digital literacy on online learning engagement would be enhanced by parents' educational expectations.

The conceptual framework of the moderated mediation model is shown in Figure 1.

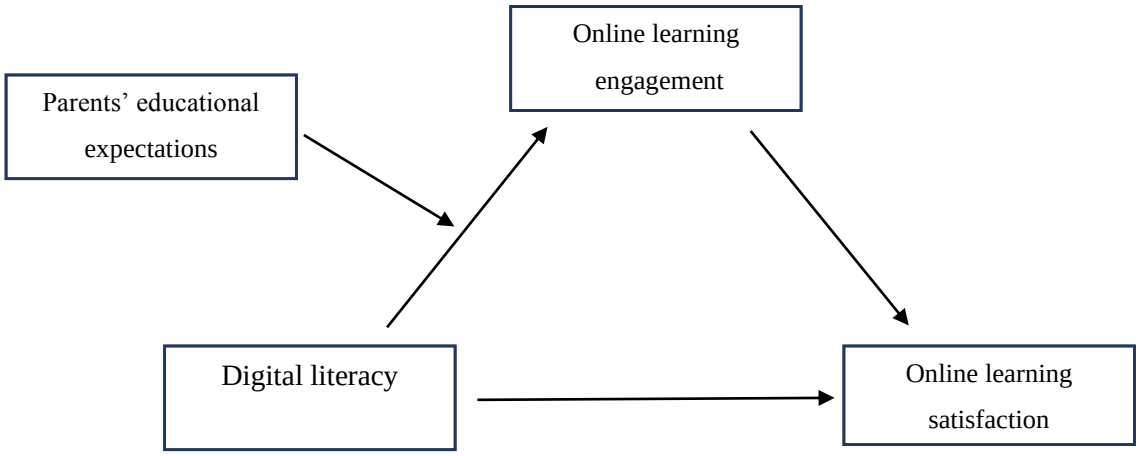

Figure 1 Digital literacy influences online learning satisfaction: A moderated mediation model

Methodology

Research Methods

Owing to the advantages of low cost, easy implementation, and accurate information, (Maheshwer, 2023), this study adopted a survey-based quantitative research approach to collect data. Through statistical analysis employing mediation model analysis and moderated mediation model analysis, the internal mechanism of the relationship among digital literacy, online learning engagement, online learning satisfaction, and parents' educational expectations was investigated.

Participants and Procedures

A total of 983 students from two junior high schools in China were selected through the cluster sampling method during the period from March to April 2022 to complete the questionnaire. The selection of these two schools aimed to balance the online learning circumstances of urban and rural students. The data was collected during the coronavirus lockdown and we had to resort to online surveys. We developed an online questionnaire using the Survey Star platform and subsequently generated a quick response (QR) code and a link. The head teachers of the junior high schools sent these to the WeChat or QQ groups of each class, which were frequently-used online social media platforms. After entering the questionnaire, the content of informed consent was presented first. We promised that the answers only be used for scientific research and won't be disclosed to any individual or institution. We also encouraged them to approach the questionnaire with care and independence, highlighting that there were no standard answers. Participation was voluntary, students could withdraw freely. The study complied with the Declaration of Helsinki and was approved by the Research Ethics Review Committee of Jiangxi Normal University's School of Psychology. All the adolescents received oral and written information. The written information was distributed to their parents or legal guardians. Informed consent to participate was obtained from the adolescents and their parents or legal guardians.

We deleted data from participants who answered questions in less than 180 seconds. The data of the participants who regularly answered were also deleted, such as the same choice in all items or a regular pattern of choices. The online survey was set to complete all questions before submission, so there were no missing values for all participants. After removing unqualified data, we finally got 916 (M_{age} = 13.51, SD_{age} = 1.44) valid questionnaires. There were 462 boys (50.4%) and 454 girls (49.6%); the academic year included 474 students in seventh grade (51.7%), 259 students in

eighth grade (28.3%), and 183 students in ninth grade (20%); 566 urban students (61.79%) and 350 rural students (38.21%).

Measures

Digital literacy

The digital literacy scale (Ng, 2012) was used to assess adolescents' digital literacy. It was composed of 10 items (e.g., "I am confident with my search and evaluate skills in regards to obtaining information from the Web"), including three dimensions: technical, cognitive, and social-emotional. Each item was rated on a 4-point scale ranging from 1 (*Unskilled*) to 4 (*Extremely skilled*). The Cronbach's α coefficient of the current participants was 0.90. The confirmatory factor analysis (CFA) showed an acceptable fit ($\chi^2(29)$ = 205.26, RMSEA = 0.08, CFI = 0.96, TLI = 0.94, SRMR = 0.04) (Wang, MC 2014).

Online learning engagement

The Chinese version of the Utrecht work engagement scale-student (UWES-S) (Schaufeli, Martínez, Pinto, Salanova & Bakker, 2002) revised by LT Fang, Shi and Zhang (2008) was adopted, which included three dimensions of Vigor, Dedication, and Absorption with good reliability (Zhang, D, Zhang, Cao, Zhu & Yang, 2023). There were 17 items on the scale (e.g., "I can get carried away by my studies"). The instruction suggested that the study here refers to online learning during COVID-19. Each item was measured on a 7-point Likert scale ranging from 1 (*Never*) to 7 (*Always*). The Cronbach's α coefficient of the current participants was 0.95. The CFA showed an acceptable fit ($\chi^2(108)$ = 745.82, RMSEA = 0.08, CFI = 0.95, TLI = 0.94, SRMR = 0.04) (Wang, MC 2014).

Parents' educational expectations

We used the perceived parental expectation (PPE) subscale which assessed the parental expectation related to an individual's success in pursuing a career and academic performance (Wang, LF & Heppner, 2002) with good reliability (Leung, Hou, Gati & Li, 2011). The adapted scale consisted of nine items (e.g., "Parents expect my academic performance to make them proud"). Each item was rated on a 6-point scale ranging from 1 (*Not at all expected*) to 6 (*Very strongly expected*). Cronbach's α coefficient of the scale was 0.88 in our study. The CFA showed an acceptable fit ($\chi^2(19)$ = 114.424, RMSEA = 0.07, CFI = 0.97, TLI = 0.94, SRMR = 0.04) (Wang, MC 2014).

Online learning satisfaction

The satisfaction with the online learning orientation scale (Abdous, 2019) was used to assess adolescents' online learning satisfaction. There were 11 items on the scale (e.g., "I feel that I will be less isolated in my online course"). It consisted of two dimensions: satisfaction with online learning and sense of preparedness (Abdous, 2019). All items were measured on a 5-point Likert scale ranging from 1 (*Strongly disagree*) to 5 (Strongly *agree*). Cronbach's α coefficient of the scale was 0.93 in our study. The CFA showed an acceptable fit ($\chi^2(41)$ = 262.30 RMSEA = 0.08, CFI = 0.97, TLI = 0.96, SRMR = 0.03) (Wang, MC 2014).

All the scales we employed were derived from published papers. PPE was in Chinese, and UWES-S was a revised Chinese version with good reliability and validity. As for the digital literacy scale and the satisfaction with the online learning orientation scale, we enlisted one graduate student majoring in English and one in psychology to translate the English scales into Chinese. Then we invited two more graduate students, one specializing in English and the other in psychology, to translate the Chinese-translated scales back into English. By comparing the re-translated English scales with the original English scales, the accuracy of the translation was checked and potential issues or discrepancies were identified. We changed the term "orientation" in the satisfaction with the online learning orientation scale to "online courses" to make it applicable to this study. Before the formal use, a small group of junior high school students was selected for a pre–test. We inquired whether they could comprehend the meaning of the items and further adjusted and optimised the wording of the scales. It was found that these scales demonstrated good reliability and acceptable validity. These measures aimed to minimise the influence of cultural differences and ensure the correctness of translation.

Analyses

SPSS 23.0 was used for data entry, sorting, and the calculation of bivariate Pearson correlations among the study variables. Mplus 8.3 was used for CFA. The goodness-of-fit indices included the chi-square test value (χ^2), the degree of freedom (*df*), the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root-mean square error of approximation (RMSEA), and the standardised root-mean-square residual (SRMR) (Zhang, X & Wu, 2024). PROCESS, a computational tool and a "macro" plug-in compatible with Statistical Package for Social Science (SPSS) and Statistical Analysis System (SAS) was able to directly test models involving mediation, moderation, or both simultaneously. By selecting a pre-programmed model number and selecting the "role" of each variable in the model, PROCESS could easily estimate the parameters of each equation through ordinary least squares regression (Hayes, Montoya & Rockwood, 2017). Model 4 was applied to test the mediation effect of online learning engagement, and Model 7 was used to test the moderation effect

of parents' educational expectations. Before the mediation model and moderated mediation model analyses, all variables were standardised. In the model analyses, 5,000 bootstrap resamples were selected to calculate the 95% confidence intervals (CIs) (Hayes, 2013).

Results

Describe Statistics and Correlation Analysis

Table 1 showed mean value, standard deviation, and correlation coefficient between each two variables. Digital literacy, online learning engagement, and online learning satisfaction were moderately correlated (r = 0.40-0.51), which was the basic criterion for mediating analysis; weak correlations (r = 0.16-0.22) existed between parents' educational expectations and the first three variables, meeting the ideal condition that moderating variable had little to do with either the independent or dependent variables (James & Brett, 1984).

Table 1 Means, *SD*, and correlations of all study variables (n = 916)

Variables	*M*	*SD*	1	2	3	4
1) DL	2.30	0.57	1			
2) OLE	4.42	0.99	0.41***	1		
3) OLS	3.38	0.73	0.40***	0.51***	1	
4) PEE	3.70	0.97	0.19***	0.22***	0.16***	1

Note. ***p < .001. DL = digital literacy; OLE = online learning engagement; OLS = online learning satisfaction; PEE = parents' educational expectations.

Mediation Effect Test

We applied Model 4 of the PROCESS macro to test the mediation effect. In the case of gender and age as covariates, the results of the model test showed a direct effect between DL and OLS (β = 0.23, t = 7.52, p < 0.001), which supported Hypothesis 1. DL had a positive relationship with OLE (β = 0.41, t = 13.34, p < 0.001); OLE positively associated with OLS significantly (β = 0.41, t = 13.26, p < 0.001). We could know that OLE played a partial mediating role between DL and OLS. The mediation effect accounted for 42.02% of the total effect of DL on OLS. Hypothesis 2 was verified. The mediating effect results were illustrated in Table 2.

Table 2 OLE as a mediator between DL and OLS (n = 916)

	Model 1: OLS		Model 2: OLE		Model 3: OLS		Model 4: OLE	
	β	*t*	β	*β*	β	*t*	β	*t*
Sex	-0.12	-1.95	-0.15	-2.48*	-0.06	-1.04	-0.12	-2.08*
Age	-0.05	-1.73	-0.08	-2.50*	-0.02	-0.78	-0.07	-2.53*
X: DL	0.40	12.90***	0.41	13.26***	0.23	7.52***	0.34	10.64***
M: OLE					0.41	13.26***	0.13	4.43***
X*W							0.11	3.94***
R^2	0.17		0.18		0.30		0.21	
F	61.36***		67.39***		98.78***		49.80***	

Note. *p < .05; **p < .01; ***p < .001.

Moderated Mediation Effect Test

We used Model 8 of the PROCESS macro to test the moderating role of PEE in the mediation process (Hayes, 2013). The results were presented in Model 4 of Table 2. They indicated that the association between DL and OLE was significant (β = 0.34, t = 10.64, p < .001), and this association was moderated by PEE (β = 0.11, t = 3.94, p < .001), which supported Hypothesis 3.

To further investigate the moderating role of PEE in the mediation path, we performed the simple slope analysis. The results indicated that the positive relationship between DL and OLE was relatively stronger for students with high PEE (β_{simple} = 0.45, t = 12.91, p <.001) than for students with low PEE (β_{simple} = 0.23, t = 4.80, p < .001). The results were presented in Figure 2.

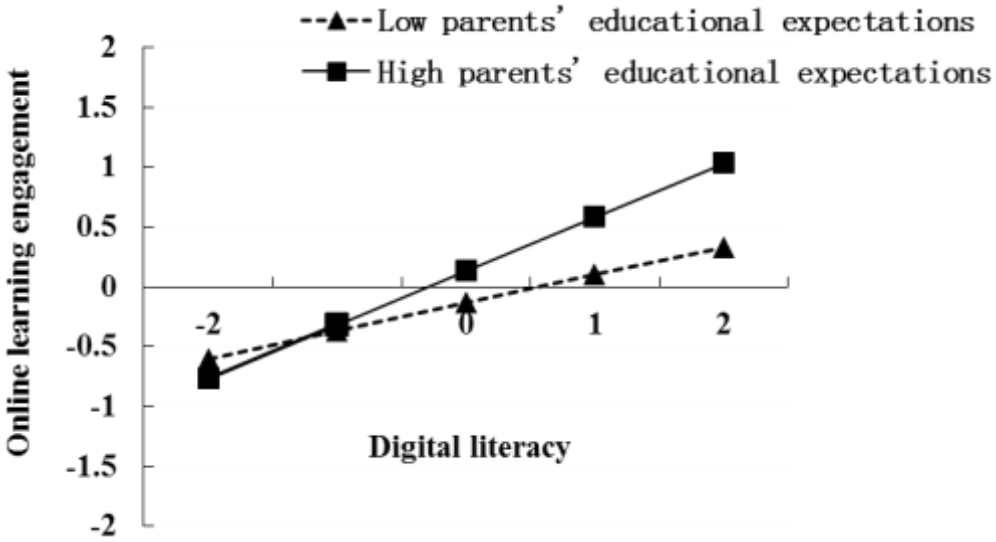

Figure 2 Simple slope analysis of parents' educational expectations between digital literacy and online learning engagement

We found the positive association of DL with OLS was explained partly by OLE. Moreover, the indirect association between DL to OLS was stronger for individuals with high PEE.

Discussion

Under the background of digitalisation, many countries have realised the digitalised transformation of education, introduced educational informationisation policies and made a lot of development and investment in digital learning technologies and online learning platforms (Mehta, Morris, Swinnerton & Homer, 2019). Such as the National Education Technology Plan (NETP) released by the United States every 4 or 5 years since 1996 (Roumell & Salajan, 2016), the Digital Education Action Plan (2021–2027) formulated and promulgated by the European Union (EU) in 2020 (European Commission, 2020), the South African National Digital and Future Skills Strategy signed by South Africa's Minister of Communications and Digital Technology (Department of Communications and Digital Technologies, Republic of South Africa, 2020), and so on. In 2021, China issued an Action Program to Improve DL and Skills for All Citizens (Office of the Central Cyberspace Affairs Commission of China, 2021). DL is not only the core of skills in the 21st century, but also the foundation of lifelong learning in the digital economy era. Online-offline hybrid teaching will be an education mode that the world continues to explore and develop. But before the COVID-19 pandemic, online learning wasn't used by basic education students mainly, so most of the research on online learning was focused on college education (Hachey, Conway, Wladis & Karim, 2022; Martin, Sun & Westine, 2020). To effectively prevent the spread of the virus during the period of COVID-19, online teaching has been used to maintain the continuity of education worldwide in various degrees. As a new way of learning through network technology and digital media with flexibility and ubiquity, students can learn anytime anywhere. Rich network resources and convenient information access enable students to share resources quickly and form new learning ways and growth paths (He, 2002). So, this study explored the relationship between DL and the OLS and its internal mechanism.

The DL of junior high school students was positively associated with their OLS. As we all know, the basic elements of teaching activities are teachers, students, teaching content, and teaching media. Most studies on learning satisfaction explore the influencing factors from these four angles. From the perspective of students, most previous studies have explored the effects of their learning attitude, motivation, and self-efficacy on OLS (Cheng & Zhao, 2015; Li, B, Zhang, Zhang & Zhao, 2016; Yan, Wang & Li, 2021). But different from traditional learning in the classroom, online learning requires students to operate digital devices to complete learning tasks such as lectures, exercises, and homework. With the transition from traditional face-to-face learning to online learning environments, learners may feel ill-adapted (Abdous, 2019) and intimidated (McCaul, Durao, Kredo, Garner, Young & Rohwer, 2021). Students with high DL have stronger network technical, cognitive, and social-emotional abilities. Therefore, in the online course during COVID-19, they can

participate in online learning with high proficiency, thus generating higher OLS.

The Mediating Effect of Online Learning Engagement

The mediation model analysis results showed that OLE partially mediated the association between DL and OLS. The effective use of information technology and digital learning resources can enhance learners' emotional, cognitive, and behavioural input by directly influencing multiple mediating factors such as learning motivation and learning interest (Gu, Wang & Wang, 2016; Kara, 2022). The results confirmed the conclusion again and extended the conclusion to junior high school students. Students with high DL are equipped with stronger abilities and qualities (Office of the Central Cyberspace Affairs Commission of China, 2021), so they can maintain online learning faster and longer, and increase engagement in online learning. Good information application ability is better reflected in the network learning mode, so students have a higher enthusiasm to participate in the network learning communication, good information awareness helps students to adopt a positive and proactive attitude to solve problems (Zhai, Chen & Wang, 2020). The higher the level of engagement in online learning, the more they can appreciate the convenience of online learning, learn more efficiently, examine more underlying emotions, and thus have higher satisfaction.

In the era of the digital economy, the cultivation and promotion of DL will become the leader in developing students' core literacy. The results also demonstrate the necessity of these measures at the micro level. The improvement of students' DL is good for the improvement of online learners' learning engagement and OLS, thus promote the digital transformation of education. Digital development of education will promote education equity and the development of social politics, economy, and culture. There are still many obstacles to digitizing education in low- and middle-income countries and regions, such as a lack of digital infrastructure, network access, and teachers' support. Governments and educational institutions should strengthen investment in digital equipment and strengthen the training of teachers' digital abilities to enhance students' digital abilities, bridge the digital gap, and cope with other crises in the future (Duby, Jonas, Bunce, Bergh, Maruping, Fowler, Reddy, Govindasamy & Mathews, 2022).

The Moderating Role of Parents' Educational Expectations

The results of the moderating effect test showed that PEE moderate the first half path of the mediating effect of DL on OLS. The association between DL with OLE was closer for junior high school students with high PEE and weaker for vice versa. In other words, PEE enhanced the effect of DL on OLE, which conformed to the protective-enhancing model (Li, DP 2012). Harrell and Bower (2011) point out that basic information literacy can improve the persistence of online learners, but with the improvement of learners' information literacy level, learners will reduce their attention to course content and learning tasks due to the interference of various activities in the network and thus tend to stop learning. Adolescents who perceived high PEE had higher self-expectations for education (Rimkute, Hirvonen, Tolvanen, Aunola & Nurmi, 2012). PEE are reflected through their intelligence, energy, and economic investment in their children's education (Jacobs, 2023). Scott (2023) finds that online learning is affected by parental supervision. Therefore, junior high school students with high PEE have clearer learning goals and stronger learning motivation in the online learning process during the pandemic, and will consciously apply good DL to online learning rather than to other disruptive activities unrelated to learning tasks. So, we suggest improving the DL of junior high school students and attaching importance to the improvement and reasonable expression of PEE.

Conclusion

In conclusion, the findings showed that Chinese junior high school students' DL had a positive relationship with OLS. Students' DL also had an indirect effect on OLS through OLE. The connection between DL and OLE was moderated by PEE. Compared with the students with lower PEE, the junior high school students with higher PEE had a stronger indirect effect. These findings provide insight to understand how DL will influence the OLS of junior high school students. Although the data in this study was collected during the COVID-19 pandemic, with the increasing use of digital products in education, the findings were also helpful in understanding the underlying mechanisms of online learning outcomes for junior high school students in non-pandemic contexts. In addition, these findings could also be applied in future studies to examine OLS in different age groups or cultural contexts.

Data Availability Statement

The data supporting this study's findings are available from the corresponding author upon reasonable request.

Acknowledgements

Special thanks to the junior high school students who participated in the survey and the teachers who assisted in completing the survey. This research was funded by the Jiangxi Province Education Science Planning Project (Project Number: 21YB209).

Authors' Contributions

All authors contributed to the study's conception and design. BL performed material preparation and data collection. XL and JW completed the data analysis. XL wrote the first draft of the manuscript. BY guided the whole research process and commented on previous versions of the manuscript with LG and JW. All authors read and approved the final manuscript.

Notes

i. Published under a Creative Commons Attribution Licence.
ii. DATES: Received: 26 December 2023; Revised: 19 November 2024; Accepted: 30 November 2024; Published: 30 November 2024.

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