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Development and Validation of a Farmer's Focused Digital Literacy Scale

Saurabh Chandra[1]*, Kalyan Ghadei[2], M. Chennamadhava[3] and Waris Ali[4]

[1,3&4]Ph.D. Scholars, [2]Professor, Department of Agricultural Extension Education, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221005, Uttar Pradesh, India
*Corresponding author mail id: 2407saurabh@gmail.com

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ABSTRACT

The research aimed to develop a tool for assessing the digital literacy of farmers towards ICT-led agriculture in India. The study identified three dimensions namely digital knowledge, attitude, and digital competency, for a farmer-focused digital literacy scale. Digital competency consisted of seven sub-dimensions viz device setup, digital communication and collaboration, digital content creation and sharing, digital safety, problem-solving, digital marketing, and digital payment. The digital literacy scale was developed with Likert scale construction methodology. An overall mean relevancy score of 5.693 was obtained. A pilot study was conducted with 60 farmers in a non-sampled area. The t-value was calculated, and the cutoff value for item selection was set at $\geq$ 1.75. For assessing internal consistency reliability using the Spearman-Brown formula, a reliability coefficient of 0.850 was found. The calculation of Cronbach's alpha gave a value of 0.743, indicating that the scale shows a high level of consistency in its measurement. The standard farmers-focused digital literacy scale comprised of 30 items, and its content validity was determined with expert opinions.

INTRODUCTION

India's agriculture is evolving from traditional sustenance farming to a pathway for enhancing the overall quality of life and livelihoods. Information and communication technology (ICT) orientation positively impacts job performance. Farmers seek timely and relevant information on agricultural practices from various sources. It can significantly contribute to rapidly spreading innovative technology (Nain et al., 2015). Integrating digitalization with creative activities requires creative professionals to make continuous adjustments. Critical thinking and problem-solving are crucial for utilizing creative expression and digital communication processes. Knowledge of ICT positively influences the motivation of people (Medina-García et al., 2021). ICT devices like smartphones and tablets have made the internet an integral part of everyday life, allowing people to personalize their experiences by filtering content through various platforms. The Governments implement measures to enhance digital literacy, recognizing its economic benefits (Murray & Perez, 2014). Digital literacy involves the acquisition of technical, cognitive, and socio-emotional skills necessary for effectively engaging with digital technology, both in online and offline contexts.Digital literacy is defined as a person operating digital devices (like Tablets, Smartphones, etc.) sending and receiving e-mails & browsing the Internet for information, and undertaking digital payment, etc. (PMGDISHA, 2018). Digital literacy involves the acquisition of technical, cognitive, and socio-emotional skills necessary for effectively engaging with digital technology, both in online and offline contexts (Ng, 2012). Digital tools and technologies have transformed agricultural extension services by providing farmers with convenient access to information, customized guidance, and timely advisory support. Digital technologies have ushered in a new era of agriculture extension services, offering unprecedented opportunities to transform traditional farming practices (Singh et al., 2023).

From the study point of view, Farmer's Functional Digital Literacy was conceptualized as the ability of the farmer to utilize

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the full potential of ICT-based tools, techniques, applications, and networking potential for effectively and efficiently carrying out agricultural and allied activities for livelihood and continuous improvement in the existing digital skill. It will include the ability of farmers to operate modern ICT-based tools (like Smartphones, tablets, laptops/computers) and networking services, applications (internet, SMS, conferencing, mobile app, website, *etc*.) for obtaining information related to their farming activities, create small videos, share videos, capture and share live photos for accessing e-advisories, read, write and send messages, e-mail, seeking marketing related information and initiating business activities based on that, making the financial transaction in the digital ecosystem, *etc*. without any outside support with relative ease.

METHODOLOGY

The scale comprehensively covered all aspects of farmers' focused digital literacy domain. The scale has three domains namely; cognitive (knowledge), affective (attitude), and psychomotor (competency) learning. All of the items had high differentiating values and met the procedural requirements of Likert's summating rating scaling technique (Sidaray, 2022). The standardized farmer's functional digital literacy scale followed the Likert method of summated rating scale construction (Likert, 1932). The 5-point psychological continuum was used to measure the farmers-focused digital literacy among the farmers in the utilization of tools and techniques in agriculture. A pool of statements was collected from diverse sources, including literature, interactions with scientists, extension professionals, NGO personnel, government officials, farmers, teachers, senior citizens from different societies, and other stakeholders. A total of 100 items were collected. The statements consisted under broader three dimensions namely digital knowledge (cognitive), attitude (affective), and digital competency (psychomotor) domains of learning. The screening items passed through 14 informal criteria for attitude statements construction proposed by Edward (1969); Wang (1932); Thurstone & Chave (1929); Kilpatrick (1948), and finally, 50 items found to be related to the study. The relevant items prepared in the questionnaire form in a five-point psychological continuum. For expert judgment (opinion), questionnaires were communicated to 100 professionals with specialized knowledge in the domain of extension education. As per the expert opinion, the questionnaire was prepared for the pilot study. The researcher interviewed 60 farmers and collected the data. The data underwent t-value calculation, and items with a t-value equal to or exceeding 1.75 were chosen based on previous studies by Edward in 1957.

$$\text{RW} = \frac{MR + R + SWR + LR + NR}{MPS}, \text{MRS} = \frac{MR + R + SWR + LR + NR}{n}$$

Whereas, MR = Most relevant (5), R= Relevant (4), SWR = Some What Relevant (3), LR= Less Relevant (2), NR= Not Relevant (1), MPS= Maximum Possible Score (40×5 = 200), n=Number of judges (40)

$$\text{OMRS} = \frac{\text{MR + R + SWR + LR + NR}}{\text{Number of Judges} \times \text{Number of statements}}$$

$$t = \frac{\bar{X}H - \bar{X}L}{\sqrt{\frac{\sum(X_H - \bar{X}_H)^2 + \sum(X_L - \bar{X}_L)^2}{n(n-1)}}}$$

Whereas,

$$\sum(X_H - \bar{X}_H)^2 = \sum(X_H)^2 - \frac{(\sum X_H)^2}{n} \text{ and } \sum(X_L - \bar{X}_L)^2 = \sum(X_L)^2 - \frac{(\sum X_L)^2}{n}$$

$\bar{X}_H$ = Mean score of given statements in the high group, $\bar{X}_L$ = Mean score of given statements in the low group, $\Sigma(X_H)^2$ = Sum of squares of individual scores on a given statement for the high group, $\Sigma(X_L)^2$ = Sum of squares of individual scores on a given statement for the low group, ΣX_H = Summation of scores on a given statement for the high group, and ΣX_L = Summation of scores on a given statement for the low group,Relevancy Weightage (RW) > 0.85, Mean Relevancy Score (MRS) > Overall Mean Relevancy Score (OMRS) *i.e.,* 5.693.

A carefully constructed scale was developed with the help of 40 experts belonging to the field of extension education. They reviewed all of the revised statements and gave their expertise on the selection of the final statements. Finally, 30 items under three domains are considered to assess the farmers focused- digital literacy. The Cronbach alpha coefficient was determined using an SPSS tool version 26.0. The scale was administered to 60 farmers of non-sampled areas. The scale's reliability was assessed using the split-half method. The scale was divided into two sets based on the odd and even numbers of items with the help of following formula.

$$R = \frac{2r}{1+r}$$

Whereas, R = reliability coefficient of the whole scale, r = Estimated correlation between two (sets) halves

RESULTS

Table 1 presents the mean relevancy score, relevancy weightage, overall mean relevancy score, and t-value estimation of the selected items. The table 1 includes various statements related to digital knowledge, attitude, digital competency, digital communication and collaboration, digital content creation and sharing, digital safety, problem-solving, digital agriculture, digital marketing, and digital payments. To standardize the scale, the reliability and validity were assessed using techniques such as the split-half (Spearman-Brown coefficient) reliability coefficient, Pearson correlation coefficient, and Cronbach's alpha. Subsequently, expert opinions were subjected to content validity for scale validation.

Validity and reliability analysis

Reliability pertains to the extent of consistency observed across multiple measurements of a given variable. In this study, we utilized the Cronbach alpha coefficient, a measure of internal consistency, to assess the reliability of the measurement instrument. The calculation of the Cronbach alpha coefficient using SPSS yielded a value of 0.743, indicating a satisfactory level of reliability for the scale. Furthermore, the scale's reliability analysis

Table 1. Mean Relevancy Score (MRS), Relevancy Weightage (RW), Overall Mean Relevancy Score, and t-value estimation of the selected items

S.No.	Item Statement	RW	MRS	t-value
	Digital knowledge			
1	You know ICTs tools, applications and to download, delete and safely use?	1.21	6.05	2.890
2	You have Knowledge regarding cropping patterns, weather phenomena, and rainfall patterns to use DSS in Agricultural forecasting?	1.905	9.525	3.022
3	You know to use the internet to browse the latest and updated agriculture information?	1.19	5.920	3.621
	Attitude			
4	You can operate different ICT tools and techniques related to agricultural aspects.	1.175	5.875	3.404
5	You feel that digital literacy reduces the time lag to solve the problem.	1.18	5.900	3.350
6	You feel that digital literacy requires deducing the duplication of information	1.53	7.65	3.243
	Digital competency, Device setup			
7	You can set up a SIM card; charge smartphone, laptop, tablet, etc., and turn it.	1.515	7.575	3.170
8	You can reset data, devices, and applications and restore devices in their own mobile phone, computer, etc.	1.115	5.575	3.118
9	You can safely download the application on your own device.	1.5	7.500	3.228
10	You are able to set up various agricultural Apps and portal (like Digital Mandi App Kisan Suvidh app, e-NAM, m-Kisan portal) on their own device.	1.12	5.700	3.375
	Digital communication and collaboration			
11	You are able to make the video conferencing to multi-stakeholders.	1.21	6.050	3.692
12	You can solve the agricultural problem by collaborating and communicating with stakeholders.	1.265	6.325	3.666
13	You are able to create new farmers' groups on various social networking platforms like Facebook, WhatsApp, Instagram, etc.	1.15	5.750	3.187
14	You are able to create and handle social media (Facebook, YouTube) for sharing agricultural information with fellow farmers.	1.775	8.875	3.172
	Digital content creation and sharing			
15	You are able to use, presentation, uploading and downloading of agricultural e-content on information Kiosk.	1.79	8.950	3.274
16	You are able to use, create and sharing agricultural information through SMS, voice message and podcast.	1.54	7.700	2.549
17	You are able to share agricultural content (i.e., images, videos, and website links) through social networking platforms.	1.79	8.950	2.953
	Digital safety			
18	You are able to register for different Apps and log in with a phone number and password.	1.475	7.375	2.591
19	You are able to not disclose passwords and sensitive information with fellow farmers.	1.495	7.475	2.982
20	You are aware that file sharing is illegal due to copyright laws.	1.15	5.750	3.213
21	You are able to use e-communication and collaboration safely.	1.105	5.525	1.892
	Problem-solving			
22	You can find the right and relevant information from various sources.	1.18	5.900	3.168
23	You are able to whether post an advertisement of their produces.	1.265	6.325	2.936
24	You are able to make a video call with experts to take the right advice.	1.175	5.875	2.898
	Digital agriculture			
25	You feel that digital agriculture has potential to promotes effective and efficient use of natural resources (like land, water etc.)?	1.26	6.300	2.657
26	You feel that digital agriculture has potential to analysis real farm information at right time?	1.20	6.010	3.100
	Digital marketing			
27	You are able to sell your produce on the e-NAM platform.	1.18	5.900	2.804
28	You are feeling that digital marketing provides cost effective, time saving & efficient marketing opportunity.	1.32	6.600	2.348
	Digital payments			
29	You feel that digital payment is more convenient & safer system compare to conventional payment system.	1.365	6.825	3.050
30	You feel that digital payment system has potential to provide opportunity 24X7 hours.	1.21	6.050	3.200
	OMRS	5.693		

demonstrated strong consistency, as both the split-half (Spearman-Brown coefficient) and Pearson correlation coefficient achieved values of 0.850 and 0.739, respectively.

The validity of a scale is determined by its ability to measure the intended construct accurately. Validity assesses the degree to which a scale faithfully represents the concept or construct under investigation. Content validity, in particular, concerns the appropriateness and representativeness of the items within the scale in relation to the overall content domain. In this study, we established content validity by collecting statements from relevant literature and seeking the opinion of experts in the field of extension, who possess bring vast experience in this.

DISCUSSION

In this study, we focused on assessing the reliability and validity of the measurement instrument used to gather data for our research. Reliability, as discussed earlier, pertains to the consistency of measurements over multiple instances. To ensure the reliability of our measurement instrument, we employed the Cronbach alpha coefficient, a widely recognized measure of internal consistency. The calculated Cronbach alpha coefficient, which was 0.743, suggests a satisfactory level of reliability for the scale. This indicates that the items within the scale are consistently measuring the same construct across different respondents, reinforcing the confidence in the scale's reliability (Cronbach, 1951). Furthermore, additional analyses to support the scale's reliability was conducted as used by other researchers (Kumar et al., 2015, Kumar et al., 2016; Shitu et al., 2018; Gupta et al., 2022). The split-half reliability, as measured by the Spearman-Brown coefficient, yielded a value of 0.850. Additionally, the Pearson correlation coefficient, which measures the consistency of responses across the scale items, resulted in a value of 0.739. These results further validated the strong consistency of the scale's items, reinforcing the reliability of our measurement instrument (Nunnally, 1978). Turning our attention to validity, which assesses the extent to which our measurement instrument accurately represents the concept under investigation, we specifically focused on content validity. Content validity is essential as it ensures that the items within the scale are relevant and representative of the overall content domain.

First, precisely and meticulously reviewed the relevant literature to identify and select items that had been used in previous research and were conceptually related to the construct of interest in order to establish content validity. This literature review helped to ensure that the selected items were theoretically sound and in line with the research domain. To further strengthen content validity, sought the input of experts in the field of extension, who possess vast experience and expertise in the subject matter. These experts provided their valuable insights and opinions on the appropriateness and representativeness of the scale items. Their input and feedback were crucial in refining the scale to accurately measure the intended construct. By combining a thorough literature review and expert opinions, we have taken important steps to establish the content validity of our measurement instrument. These efforts ensure that the items within the scale are both conceptually and practically relevant to the research domain, strengthening the validity of our instrument (Polit & Beck, 2006). The results of reliability analyses, as well as the steps taken to establish content validity, provide a strong foundation for the validity of our measurement instrument. These procedures are essential for ensuring that the data collected in our study are not only consistent but also accurately represent the construct under investigation, thus enhancing the overall quality of our research.

CONCLUSION

The digital literacy scale that has been developed proves to be a valuable and strong instrument for the comprehensive evaluation of the digital literacy levels among Indian farmers. Its meticulous construction, rigorous validation process, and a high degree of reliability emphasize its applicability in assisting policymakers, researchers, and stakeholders within the agricultural sector. This tool is well-suited for gaining insights into the specific digital literacy requirements of farmers as they engage with modern agriculture practices driven by information and communication technology (ICT). Furthermore, it has the potential to serve as a catalyst for targeted interventions and initiatives that aim to augment the digital literacy skills of farmers. By enhancing their digital literacy, this tool has the capacity to contribute to increased efficiency and success in the adoption of ICT-based agricultural practices, ultimately benefitting the agricultural landscape in India.

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