**Journal of Informatics Education and Research**
**ISSN: 1526-4726**
**Vol 4 Issue 3 (2024)**

# Assessing the Competence of Digital Tools in Quality Education: A Scale Development for Supporting SDG4

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**Abstract**
This study aims to develop a comprehensive scale for assessing the competence of digital tools in fostering quality education, aligning with Sustainable Development Goal 4. The research addresses the need for a robust evaluation framework to measure the effectiveness of digital tools used in educational settings. The scale development process involves three key stages: item generation, validation, and data collection.

**Item Generation:** Initial items for the scale are derived from an extensive review of literature, expert consultations, and user feedback. This process ensures the scale encompasses a wide range of relevant factors impacting digital tool effectiveness. The study employed a 7- & 5-point Likert scale & Binary scale encompassing 27 items along with 6 demographic items, with a sample size of 202 participants.

**Validation Process:** The scale undergoes pilot testing with educators/instructors & Learners. Reliability is assessed using Cronbach's Alpha, while Confirmatory Factor Analysis (CFA) is employed to establish construct validity.

**Participants and Data Collection:** Data is collected through structured surveys administered to a diverse group of stakeholders including educators, instructors, students, professionals and academicians.

**Findings:** Preliminary results from pilot testing indicate strong reliability and validity of the scale, with Cronbach's Alpha demonstrating internal consistency and CFA confirming the scale's factor structure. Key findings suggest that the scale effectively measures various dimensions of digital tool competence, providing actionable insights for educators, policymakers, and technology developers to enhance the integration of digital tools in education. The evaluation study revealed valid results in terms of scale fit criteria, internal validity, and reliability.

**Implications:** The developed scale offers a valuable tool for evaluating digital open resources, guiding improvements in educational technology, and supporting the achievement of SDG 4 by ensuring that digital tools contribute effectively to quality education.

**Keywords:** Digital Tools, Quality Education, SDG4, Inclusion

## 1. Introduction

1.1 Education and Sustainable Development Goals 4

Education is a public good, a core human right, and a basis for other personal rights to be realized. It promotes peace, tolerance, personal fulfillment, and long-term growth. At the same time, education is necessary for creating full employment and eradication of poverty.

The United Nations 2030 Agenda for Sustainable Development lays out a new, more inclusive path to long-term viability. The Sustainable Development Goals pave the way to equity, justice, and prosperity by taking into account social, environmental and economic well-being. As a means of accomplishing the SDG‟s, Education is given special attention by directly implementing the development and improvement of e-learning effectiveness. „Focus on ensuring inclusive and quality education and promote lifelong learning opportunities for one and all. According to the Incheon Declaration and SDG 4 – Education 2030 Framework for Action (2015).(Qian Tang, 2016)

ISO created ISO 21001, the first management program benchmark on education, specifically for SDG 4, which contributes to better of educational services and meet the needs of those who use them in order to achieve education-related SDGs. (Zhang *et al.*, 2020). Furthermore, ISO/TC 232 has created standards that define the requirements for learning services provided outside of conventional schooling, , including vocational education and in- company training. For society's long-term intellectual progress, better human capital investments are required. Education can improve people's learning outcomes and professional skills, ensuring that they are ready for employment. ISO has created a total of 133 standards, all of which aid in the achievement of SDG 4. (*ISO 21001:2018(En), Educational Organizations — Management Systems for Educational Organizations — Requirements with Guidance for Use*, n .d.)

**1.2 Quality Education & Technology**

The eruption of Information and Communication Technologies (herein, ICTs) in current society has given way to a transformation of the same in many ways. One of the fields in which this has had a more significant effect concerns the educational context. Specifically, educational activities based on these ICT supports have progressively impregnated the Higher Education field. This has propitiated the transformation process of the conventional university to the digital university through new pedagogical models, new learning environments and the action of professors capable of providing the students with the knowledge, skills and abilities necessary for life [Cortese, A.D 2003). That way, all these transformations have developed into a more sustainable model of education [(Makrakis, V. 2017)

Studies have shown that the innovative use of ICTs in the academic process is aimed at obtaining educational objectives that favour positive results in higher education students [Area-Moreira, M 2016]. At the same time, these tools can improve education quality at all levels: academic, personal, and social. However, more significant support from educational institutions is required to improve the positive impact of ICTs in the teaching-learning process. At the same time, adequate professor training and updating of content and methodologies are required to allow for the development of an optimal level of the same, thus achieving 21st-century quality education [Melo, E.; Llopis, J. 2020].
Recent years have seen a wealth of empirical evidence [Giesenbauer, B.; Müller-Christ, G. 2020] supporting the use of ICTs in education to promote sustainability. Aligned with the Sustainable Development Goals set by the United Nations Organization for Education, Science and Culture [M Rieckmann - 2017 ], the digital tools directly contribute to the goal of providing inclusive and equitable education for all. Moreover, their use is linked to other Sustainable Development Goals, such as reducing social and economic inequalities and ensuring the well-being of all individuals. In essence, digital tools are a valuable response to the evolving needs of our society. From a holistic viewpoint of ICTs, their acceptance has become generalized in society. However, this requires promoting different actions to obtain as much benefit as possible from their several advantages and applications (Karamti, C 2016]. The results shown by several studies [Janssen, E.M 2019] establish that professors' perceptions of ICTs are generally positive.

The majority considers them as tools that favour active and interactive learning and that achieve respect for individual learning rhythms. Even so, more significant learning is valued in association with their use in the academic process [Jääskelä, P. 2017]. However, the results of other studies reveal that the most reluctant professors to incorporate ICTs in their professional tasks indicate several limitations associated with the everyday use of these technological tools. Among these, the studies highlight the lack of technological knowledge, traditional training and the economic investment required to implement these tools. For this reason, the knowledge, attitude and beliefs that university professors adopt when faced with the integration and use of ICTs in their academic practice will be considered critical factors for the academic and even professional success of their students [(Valeria Pandolfini, 2016)

**Rationale for Digital Tools: Digital tools can enhance teaching and learning experiences, particularly in Remote areas.**

1.3 Digital Solutions and Sustainable Development Goals

The Sustainable Development Goals (SDGs) are the most comprehensive set of standardized development goals ever agreed upon, and they must be fulfilled within a 15-year timeline, or by 2030, in ordered to be considered successful. Digital solutions are critical because they have the ability to quickly transform the world, making it a more desirable proposition for people while also having a positive impact on the achievement of all of the Sustainable Development Goals. The ICT sector and digital solutions will not be adequate to accomplish the Sustainable Development Goals, as we are all well aware. In order to fully realise the promise of digital solutions in every industry around the world, a concerted effort must be launched immediately. Collaboration between government, business, and civil society partners is essential in order to make the Sustainable Development Goals a reality. In 2015, GESI and Accenture Strategy published a report titled "SMARTER 2030: ICT solutions for 21st century. (GeSI & Accenture Strategy, "#SMARTer2030: ICT Solutions for 21st Century Challenges", 2015)

A future free of poverty and hunger as well as universal access to high-quality education and healthcare are envisioned under the United Nations Sustainable Development Goals (SDGs). When economic progress does not have a negative impact on the environment and peace and freedom reign, gender inequality will be completely eliminated. By reimagining how we live and work, Digital technologies can assist in closing the accomplishment gaps in the Sustainable Development Goals. A number of experts have revealed that it can explicitly contribute to the attainment of all 17 SDG goals as well as more than half of the 69 targets detailed in the 2030 Agenda. In 2015, GESI and Accenture Strategy published a report titled "SMARTER2030: ICT solutions for 21st century. (GeSI & Accenture Strategy, "#SMARTer2030: ICT Solutions for 21st Century Challenges", 2015)

As a result of digital solutions, people are at the core of goods and services, enabling for compelling solutions that" deliver it all": an improved user experience, lower costs and enhanced sustainability. Advanced data analytics, Massive open Online Courses (MOOC), open community platforms, augmented reality, gamification and speech recognition software are some of the most successful digital solutions now available. Education has become more accessible, less expensive and of higher quality as a result as a result of the development of digital infrastructure. An estimated 450 million people will have earned degrees through distance learning by 2030, according to this prediction. In 2015, GESI and Accenture Strategy published a report titled "SMARTER2030: ICT solutions for 21st century (GeSI & Accenture Strategy, "#SMARTer2030: ICT Solutions for 21st Century Challenges", 2015) Page7

**1.4 India's Digital Learning/Inclusion Initiatives**

THE INDIAN GOVERNMENT HAS TAKEN OUTSTANDING INITIATIVES. Govt. of India,
Ministry of Education, 2021(Ministry of Education Government of India, 2021)

1. Pradhan Mantra Gramin Digital Saksharta Abhiyaan (PMGDISHA)
2. NIOS (National Institute of Open Schooling) Virtual Open Schooling
3. A lexicon of Indian Sign Language
4. Talking/Audio Books
5. NISHTHA 3.0
6. Vidhyanjali 2. o Portal

Creating a National Educational Technology Forum (NETF) for youth and adults through Digital Literacy to lay a solid foundation for Human- Centered Recovery, Integrating Literacy and digital skills to achieve all of this, Connect, Contact, Connect, Collaborate, Coordinate, and Cooperate to ensure inclusive and quality education to encourage lifelong learning.

- To promote education in the face of the covid 19 pandemic, the Indian government created MOOCs (Massive Open Online Courses) and made them free for learners.

- (Swayam) It is an online platform created by the Indian government to give all students with an educational platform. https://swayam.gov.in/

- The Ministry of Human Resources and Development (MHRD) launched NPTEL, an online platform for multi-disciplinary students. https://nptel.ac.in

- (Shagun) is a far-reaching effort to overhaul the school education system sponsored by the Ministry of HRD's Department of School Education and Literacy, E-Pathshala and

- NROER are two other online learning resources (National Repository of Open Educational Resources).

- University of Delhi and Digital Solutions (Ministry of Education Government of India, 2021)

- ILL: The ILLL"s purpose is to build a name for itself in the field of lifelong learning education by using information and communication technologies all over the world.

- DUDISCAD: Delhi University digital infrastructure assistance for colleges and departments.
- One DU: These objectives aim to promote learning accessibility and create best practices by utilizing the benefits of available educational technologies.

- SOL: E-Learning content, Complete virtualization, Online Classrooms, and are now available. Students will have tablets, study materials will be available via cloud technology, and students will be able to complete Continuous Assessment online.

- The Centre for Professional and Technical Training (COL) is an industrial training that is part of technology the open learning campus at DU. It was formed with the objective of delivering job-oriented and skill-based vocational courses in a number of professional sectors, with the goal of giving internships and employment opportunities to young people with the assistance of training partners. Ministry of Education, 2021(Ministry of Education Government of India, 2021)

1.5 **The Need for a Scale to Assess the Effectiveness and Competence of Digital Tools in Education**

Digital tools have become integral to teaching and learning in the rapidly evolving educational landscape. These tools, from learning management systems (LMS) to interactive educational software and virtual classrooms, enhance learning outcomes, facilitate personalized instruction, and promote student engagement. However, the proliferation of digital tools necessitates a robust mechanism to assess their effectiveness and competence. Developing a standardized scale to evaluate these tools ensures they meet educational goals, provide value to educators and students, and adapt to diverse learning environments.

The effectiveness of digital tools in education refers to their ability to achieve desired educational outcomes, such as improving student performance, fostering critical thinking, and enhancing engagement. On the other hand, competence refers to how well these tools can be integrated into the educational process, considering usability, adaptability, and alignment with curriculum standards. A comprehensive assessment scale is essential to measure both these dimensions accurately. Without such a scale, educators and policymakers lack the data needed to make informed decisions about which tools to adopt, leading to potential inefficiencies and suboptimal educational outcomes.

A practical scale to assess digital tools should include multiple dimensions to capture the complexity of educational environments. These dimensions might include pedagogical effectiveness, technical usability, adaptability to different learning styles, and the ability to facilitate collaboration and communication (Means, Toyama, Murphy, Bakia, & Jones, 2014). Additionally, the scale should be flexible enough to accommodate the diverse needs of different educational contexts in higher education institutions. Including a range of stakeholders—educators, learners, and administrators—in developing and validating the scale is also crucial for ensuring its relevance and applicability.

The need for a standardized scale to assess the effectiveness and competence of digital tools in education is evident. Such a scale would provide educators, administrators, and policymakers with the necessary insights to make informed decisions, ensuring that the chosen digital tools genuinely enhance educational outcomes. As the educational landscape continues to evolve, developing and implementing such a scale will ensure that digital tools are used effectively and contribute meaningfully to the learning process.

**2. Literature Review:**

2.1 Current State of Digital Tools in Education

In the past century, education has undergone evolutionary changes that have opened up a new way to acquire knowledge and skills. Digital education was born - an evolutionary quantum leap in learning and transferring knowledge. Digital education is a paradigm in which the virtual is merged with the real, and Digital tools become critical factors in fulfilling educational tasks. (Oksana , Fysiuk et.al.)

The findings of one study mention that through Google tools, educators can keep students actively engaged, improve academic monitoring, and ensure effective communication (**Santoso, Murod, Winata, Kusumawardani & Muhtadin, 2023; Prokopenko, Omelyanenko, Ponomarenko & Olshanska, 2019).** However, to truly bring about transformation through technology, it is essential to focus on accessibility, inclusivity, student well-being, and adaptability to rapidly changing technologies. Analyzing how digital tools can be accessible to all, regardless of their socioeconomic status, place of residence, or special needs, could be a promising area for future Research.

Research can focus on the impact of digital tools on students' academic performance, motivation, and engagement in the learning process. This can help teachers and educational institutions choose the most effective methods and approaches to implementing digital technologies. Implementing these principles will undoubtedly pave the way for an enriched and future-ready educational landscape. Developing inclusive platforms and expanding the adaptability of digital tools can help reduce inequalities in access to quality education. Research in these new areas will help identify digital tools' potential in providing quality and progressive education. At the same time future research should focus on developing methods and guidelines to ensure digital tools are used appropriately in learning environments. (Santos et. al. 2024).

The results showed that digital technologies offer significant opportunities to innovate in education but also present challenges such as unequal access, the need for teacher training, and the adaptation of methodologies. Successful experiences highlighted how effective technology integration can promote critical skills and educational inclusion. It was concluded that technology is a transformative element in education, capable of improving the quality and effectiveness of teaching. However, overcoming existing barriers is essential to maximize its potential. The Research underlined the continuous need for innovation and investigation in educational technology. (Santos et. al. 2024).

(Kamaljit et. al. 2023) India is all set to widely utilize the Information and Communication Technology (ICT) related services; there are a few crucial aspects to be improved. The study specifies few points i. like requirement of paying attention to e-security in India that covers the cyber forensics, computer, and cyber security, etc. and at the same time establishing a digital evidence base is an absolute requirement in India. The same is missing for the time being. ii. There is also a need for judicial reforms in India, considering information and communication technology requirements. Concerning barriers to computer and ICT usage, no factor has the supreme majority for limiting the use of ICT in the teaching-learning process in technical and higher educational institutions; this means all factors depicted below greatly limit the use of ICT in educational institutions. ; Lack of Software Problems, a number of factors such as poor organization of resources, poor quality hardware, inappropriate software, or lack of personal access for teachers. iii. Most teachers lack the skills to use ICT in the teaching-learning process because they do not get enough training

opportunities. Providing pedagogical training for teachers, rather than simply training them to use ICT tools, is an important issue.
Many studies on the problems of integrating ICT in education found that teachers" reluctance to use new technology was a significant problem.

2.2 Existing frameworks and scales used to evaluate Digital Tools
**Quantitative studies on digital tools scale development/validation across different regions**

| AUTHORS | METHODS | SCALE/COMPONENT | TARGET SUBJECT/COUNTRY |
|---|---|---|---|
| Lai, J.W.M., De Nobile, J., Bower, M. *et al.* Comprehensive evaluation of the use of technology in education – validation with a cohort of global open online learners. *Educ Inf Technol* 27, 9877–9911 (2022). https://doi.org/10.1007/s10639-022-10986-w | confirmatory factor analysis (CFA) & thematic analysis | 28-item eight-factor model/ Standardized loading factor coefficients of the eight-factor structure model; Institutional Environment, Presence/Community, Teaching/Pedagogy, Technology, Design, Affective Elements, Behavior, Learning Outcomes | Australia |
| Vongkulluksn, V.W., Lu, L., Nelson, M.J. et al. Cognitive engagement with technology scale: a validation study. Education Tech Research Dev 70, 419–445 (2022). https://doi.org/10.1007/s11423-022-10098-9 | Confirmatory Factor Analysis, as well as both classical test theory and item response theory over three studies to validate newly created scale. | The purpose of this study is to develop a scale to measure how students use technology for different cognitive tasks, following theoretical conceptions from Bloom's Digital Taxonomy and Multiple-Document Task-based Relevance Assessment and Content Extraction. | United States of America |
| Rodríguez-Santero J, Torres-Gordillo JJ, Gil-Flores J. Confirmatory Factor Analysis of a Questionnaire for Evaluating Online Training in the Workplace. *Sustainability*. 2020; 12(11):4629. https://doi.org/10.3390/su12114629 | Bartlett's sphericity test and the Kaiser-Meyer-Olkin test to rule out that the correlations between the items constitute an identity matrix, which would discourage the use of factor analyses. / CFI GMI RMR RMSEA | Factor model for the online course evaluation questionnaire. / The 24 items of the questionnaire are grouped in five dimensions, which were obtained using EFA: pedagogical design, tutor performance, virtual environment design, timing, and transfer of learning. The instrument was developed with the intention that it could be used to evaluate any online training course. | Spain |
| Agariya, Arun & Singh, Deepali. (2012). E-Learning quality: Scale development and validation in Indian context. Knowledge | reliability analysis, sampling adequacy analysis and exploratory factor analysis / Software used SPSS-15 and | 58 scale items for identifying e-learning constructs from relevant literature review; this was followed by depth interviews with the students and faculty members of different institutes and universities all across | India |

| | | | |
|---|---|---|---|
| Management and E-Learning. 4. 500-517. | AMOS-7 software | India. A total of 21 students and 15 faculty members were interviewed for major issues that exist while elearning, this resulted in pruning and fine tuning the items. The questionnaires contained 30 dimensions from learner's perspective and 28 dimensions from the faculty member's perspective (survey items). (Sample size: 207 and 155) | |
| Pankaj Deshwal, Ayush Trivedi, H.L.N. Himanshi, Online Learning Experience Scale Validation and Its Impact on Learners' Satisfaction, Procedia Computer Science, Volume 112 2017, Pages 2455-2462, ISSN 1877-0509, https://doi.org/10.1016/j.procs.2017.08.178. | linear regression analysis /Factor analysis using SPSS/ KMO test determines the suitability of the data for the factor analysis & Bartlett's test checks for redundancy between variables so that it could be represented by factors. | 4 Factor analysis pragmatic pleasurable experience, use social experience, Hedonistic exhaustive experience & sociability experience. | India |
| Sungwoo Hwang, Hyun Kyoung Kim, Development and validation of the e-learning satisfaction scale (eLSS), Teaching and Learning in Nursing, Volume 17, Issue 4, 2022, Pages 403-409, ISSN 1557-3087, https://doi.org/10.1016/j.teln.2022.02.004. | ($\chi 2$, p < .001, Q, SRMR , RMSEA , IFI , AGFI , NFI 5, CFI , PNFI, PCFI). | 17 items with three factors: content, interface, and communication/Content validity was verified by two nursing professionals. Exploratory factor analysis, convergent validity, and internal consistency reliability were examined with 150 subjects, and confirmatory factor analysis was undertaken with 154 subjects | South Korea |
| ÜSTÜNDAĞ, Mutlu & Solmaz, Ebru & Özcan, Seher. (2022). Developing and Implementing a Student Satisfaction Scale for The Emergency Remote Teaching in Higher Education. Journal of Educational Technology and Online Learning. 5. 10.31681/jetol.1161276. | Cronbach's alpha coefficient and the Spearman-Brown coefficient, CFA & EFA | 29 items and 4 factors was obtained. The factors are "The role of the Instructor" with 11 items, "Attitude" with 7 items, "ICT Infrastructure" with 7 items and "Usability and Access" with 4 items. | Turke+A7:D12y |

**Existing Studies on Frameworks Development**

| Author | References | COMPONENTS | FOCUS AREA |
|---|---|---|---|
| Randall S. Davies Brigham Young University | Davies, Randall. (2011). Understanding Technology Literacy: A Framework for Evaluating Educational Technology Integration. TechTrends. 55. 45-52. 10.1007/s11528-011-0527-3. | This framework involves three levels: awareness, praxis, and phronesis. | First observational study that surveyed pre-service (student teachers) and in-service (practicing teachers) regarding their attitudes towards technology and technology integration. Second development of the technology literacy framework a five-year evaluation of a National Science Foundation (NSF) project which integrated learning technologies into sixth grade science classrooms utilizing a problembased learning approach. USA |
| Matthew J Koehler Michigan State University Punya Mishra Arizona State University | . The Technological Pedagogical Content Knowledge Framework. In: Spector, J., Merrill, M., Elen, J., Bishop, M. (eds) Handbook of Research on Educational Communications and Technology. Springer, New York, NY. https://doi.org/10.1007/978-1-4614-3185-5_9 | The TPACK framework describes the kinds of knowledge that teachers need in order to teach with technology, and the complex ways in which these bodies of knowledge interact with one another. | TPACK provides teachers educators with a framework that guides them to achieve meaningful and authentic integration of technology into the classroom. |
| Fabio Nascimbeni, ETF Human Capital Development Expert | Nascimbeni, F., ETF, Nina Brankovic, & Huawei 2022 Winter School. (2022). THE ETF DIGITAL EDUCATION REFORM FRAMEWORK [Report]. European Training Foundation. https://www.etf.europa.eu/sites/default/files/2024-04/Digital%20Education%20Reform%20Framework_0.pdf | The 'What': focus areas for digital education reforms; Digital infrastructure, Digital competences of educators, Digital capacity of schools, Digital pedagogies and curriculum , | To help policymakers look from a new perspective at how a digital education reform can be structured, the framework is divided into two parts: the first outlining the ''what" and the second the ''how" of |

| | | | |
|---|---|---|---|
| | | Digital education resources, Digital learning environments, Digital assessment, Digital competences of learners, Digital credentials / The 'How': critical factors for digital education reforms; Data for policy-making, Digital inclusion, Stakeholders' engagement, Financing, Quality assurance, Environmental sustainability, Teachers and learners wellbeing, Foresight capacity. | digital education policies. First, it presents nine focus areas of digital education, identifying for each area the main challenges, some specific initiatives with examples from around the world, and some tools for policymaking. Second, it discusses some transversal critical factors of digital education reforms, to guide policymakers in designing successful initiatives by making the best decisions for their context. |
| Technology Acceptance Model (Davis, 1986) | Granić, A., & Marangunić, N. (2019). Technology acceptance model in educational context: A systematic literature review. *British Journal of Educational Technology*, *50*(5), 2572–2593. https://doi.org/10.1111/bjet.12864 | TAM's core variables, perceived ease of use and perceived usefulness, | Technology Acceptance Model Technology Acceptance Model (TAM; Davis, 1989) has been one of the most influential models of technology acceptance, with two primary factors influencing an individual's intention to use new technology: perceived ease of use and perceived usefulness./ understanding predictors of human behaviour towards potential acceptance or rejection of the technology. |

## 3. Methodology

The structure of this paper is as follows. First a background review is provided, that outlines existing instruments for evaluating digital tools use in education, as well as an overview of empirical work that we have conducted to determine the dimensions and items of import when evaluating the use of digital tools in education.
The methodology section explains the Reliability through Cronbach's Alpha & Validity through Confirmatory Factor Analysis (CFA) of scale with 17 Factors of 27 items. Critical reflections regarding the evaluation of digital tools in education follow in the final sections of the paper.
3.1 Scale Components

**Respondents' socio-demographic characteristics (N = 202)**

| No | Variable | Stats / Values | Freqs (% of Valid) | Graph |
|---|---|---|---|---|
| 1 | 1 | X1..Age | 1. 18-26 (Gen Z) | \85 (42.1%) |
| | | [character] | 2. 27-42 (Millenials) | \91 (45.0%) |
| | | | 3. 43-58 (Gen x) | \24 (11.9%) |
| | | | 4. 59-68 (Boomers) | 2 ( 1.0%) |
| 2 | 2 | X2..Gender | 1. Female | \101 (50.0%) |
| | | [character] | 2. Male | \100 (49.5%) |
| | | | 3. Prefer not to say | 1 ( 0.5%) |
| 3 | 3 | X3..Educational.Background | 1. 12 Grade or Less | 9 ( 4.5%) |
| | | [character] | 2. Bachelor Degree | \29 (14.4%) |
| | | | 3. Doctorate or Post | \53 (26.2%) |
| | | | 4. Graduate or Equivalent | \16 ( 7.9%) |
| | | | 5. Post Graduate | \95 (47.0%) |
| 4 | 4 | X4..Occupation | 1. Employee | \85 (42.1%) |
| | | [character] | 2. Manager | 4 ( 2.0%) |
| | | | 3. Others | \11 ( 5.4%) |
| | | | 4. Part Timer | 6 ( 3.0%) |
| | | | 5. Public Service | 5 ( 2.5%) |
| | | | 6. Self Employed | 7 ( 3.5%) |
| | | | 7. Student | \79 (39.1%) |
| | | | 8. Without Occupation | 5 ( 2.5%) |
| 5 | 5 | X5..Region | 1. Rural | 12 ( 5.9%) |
| | | [character] | 2. Semi Urban | 15 ( 7.4%) |
| | | | 3. Urban | \175 (86.6%) |
| 6 | 6 | X6..Are.you.a.learner.or.an.educator.in.the.field.of.higher.education. | 1. Educator | 7 ( 3.5%) |
| | | [character] | 2. Educator or | 67 (33.2%) |
| | | | 3. Learner | \128 (63.4%) |

**3.2 Dimensions of Competence:** The 17 key dimensions that the scale has measured:

1. **Digital Tools & Technologies:** Digital education requires readily available, high-quality tools with high-quality content, potentially made possible by open licenses: Using them and honing their skills in creating and curating them should be encouraged for educators.

2. **Availability & Quality of Digital Media Tools:** A robust framework for digital education using digital tools and quality assurance needs to be implemented. This framework should incorporate new dimensions into the current system to facilitate quick feedback loops and prompt adjustments to the program. This will ensure fairness and promote innovation in a manner that is unbiased towards any specific technology.

3. **Sources, Variety, Scope, Reach, and Scale of Initiatives:** Digital learning technologies have a substantial impact by overcoming geographical limitations and offering adaptable solutions for vulnerable areas, therefore fostering financial inclusion and educational equity. (Filatova, Z., Galyamova, E., Burkhanova, Y. (2023). The

incorporation of digital technologies in education not only improves motivation and cognitive interest, but also requires thoughtful implementation of user engagement tactics to maximize their effectiveness. (Filatova, Z., Galyamova, E., Burkhanova, Y., 2023)

4. **Access to Education:** It is important for digital education policies to adopt the Open Education strategy, which involves changing current patterns and promoting widespread access to education from many locations such as schools, residences, or other spaces. It is recommended that they give priority to the utilization of Open Educational Resources and open teaching techniques (UNESCO 2022a).

5. **Internet Connectivity**: Digital Education innovation cycles require high connectivity standards (Van der Vlies, 2020), which should be seen as a shared responsibility of all education stakeholders.

6. **Digital Infrastructure:** is a requirement for encouraging the digitalization of educational systems, and it should prioritize inclusive and sustainable practices to ensure that everyone has access to sufficient internet connectivity and digital equipment.

7. **Digital Access:** Computers, tablets, and mobile learning devices that are appropriately equipped could distinguish between a mediocre and an exceptional digital education experience (Van der Vlies, 2020). Studies indicate that it is important to equip learners with gadgets to empower them to have control over their usage, while also ensuring that families are not compelled to participate in expensive programs that they cannot afford (Williamson et al., 2020). It is necessary to provide these devices with suitable educational applications to promote digital inclusion (OECD, 2019b). Ensuring equipment maintenance is crucial.

8. **Digital Tools Adoption:** A more thorough knowledge of students' adoption of technology may be obtained by investigating variables other than perceived utility and usability. the long-term effects of using digital tools on students' decision-making processes and academic achievement, improving our understanding of educational outcomes. (Altawalbeh, 2023)

9. **Learner & Instructor attitude towards E- Education:** It is crucial to consider several factors while analyzing the attitudes of educators and learners regarding Digital learning. These dimensions include many factors such as preparedness, involvement, content, and perceived efficiency.

10. **Socioeconomic status:** Different Socioeconomic classes underscore the necessity of implementing specific measures to guarantee fair and equal opportunities for digital learning. The differences pertain to the provision of cost-effective technology, the improvement of digital literacy, and the assistance provided to educators and learners in marginalized communities. To establish a more comprehensive and efficient digital learning environment, society must confront the socioeconomic elements that impact digital education.

11. **Higher Education Institutions:** Higher education institutions (HEIs) and their respective governments share the duty of addressing the issues associated with digital learning. Therefore, they support the adoption of all-encompassing tactics that follow the most effective methods and embrace the principle of inclusiveness. (Matsieli 2024)

12. **Institutional support for the Implementation of digital media tools:** Institutional support is vital for the successful implementation of digital media tools, as it contributes to the improvement of educational processes and the advancement of digital infrastructure. Creating a strong digital infrastructure is crucial, since it necessitates collaborative efforts from both the public and private sectors to develop legal, organizational, and economic structures that facilitate digital activities.

13. **Environmental Impact**: The environmental ramifications associated with the implementation of digital activities in education should be taken into account. This will enable future-oriented digital education reforms to align with environmentally friendly standards and promote the development of green and digital skill sets among learners.

14. **Community engagement & resilience:** Policies should be inclusively designed, implemented, monitored, and evaluated, involving educators and other stakeholders in a meaningful way at different stages of the process and through a variety of channels. The contribution of for-profit tech companies should be tightly controlled by policymakers.

15. **Policy changes:** Policymakers should be cautious about how the data generated by digital education activities are gathered, maintained, and used. At the same time, regulations pertaining to digital education should be grounded in solid evidence and support data gathering and analysis in accordance with worldwide best practices.

16. **Digital skills & Competencies:** To solve this, relevant, creative, high-quality initial and ongoing professional development should be provided to educators and students in order to equip them with the abilities, knowledge, and attitudes needed to use digital technology successfully and confidently.

17. **Equity & Inclusion:** Any measures to improve digital education should primarily address educational and digital inequality. Fundamental digital skills must be made available together with targeted actions to guarantee that, rather than hindering, digitalization promotes accessibility and inclusivity in education and training.

## 4. Findings & Results

### 4.1 Examination of factors for assessing reliability using Cronbach's Alpha

This quantitative research study primarily examined the digitalization of education and how digital tools facilitate bottom-up approaches to achieve Sustainable Development Goal 4 (SDG4). The study conducted a thorough analysis to evaluate the engagement of educators and learners. The study utilized a Likert scale with 7 and 5 points, as well as a Binary scale, which included a total of 27 items and 6 demographic items. The sample size consisted of 202 individuals. The reliability of this scale was assessed by calculating Cronbach's alpha, resulting in a coefficient of 0.89.
This outcome demonstrates a significant degree of internal consistency, implying that the items on the scale consistently and accurately measure the fundamental concepts they are designed to evaluate.

**Taasoobshirazi, G., and Sinatra, G. M. (2011)** Cronbach's alpha is a statistical measure used to assess the internal consistency of a set of items in measuring a unidimensional latent construct. The coefficient varies between 0 and 1, with higher values suggesting greater reliability. Typically, a Cronbach's alpha greater than 0.7 is seen acceptable, over 0.8 is regarded as good, and beyond 0.9 is considered exceptional (Taber 2018). The acquired value of 0.89 in this study indicates that the scale utilized has a high level of reliability, ranging from good to outstanding. This means that the items consistently reflect the construct of educator and learner participation in digitalization.

The Cronbach's alpha value of 0.89 indicates a strong correlation among the scale items, suggesting that the scale is highly reliable and robust.

### 4.2 Confirmatory Factor Analysis (CFA): Construct Validity

This is a crucial statistical technique to test whether the data fits a hypothesized measurement model. In the context of the Digital Tools questionnaire, CFA was employed to validate the instrument's factor structure, which assesses various dimensions related to digital tools and their impacts on education.

**Journal of Informatics Education and Research**
**ISSN: 1526-4726**
**Vol 4 Issue 3 (2024)**

1. **Sample Size Sensitivity:** The chi-square test p-value is highly sensitive to sample size. In contrast, RMSEA, TLI, and CFI are less affected by sample size and focus more on the practical fit of the model. *Note: p-value might be considered less critical if other fit indices are favourable.*

**2. Practical Fit:** RMSEA, TLI, and CFI provide a more nuanced understanding of model fit and are less prone to being influenced by sample size, which can be particularly useful when working with large datasets where the chi-square test p-value may not be as informative. The fit indices like RMSEA, TLI, and CFI offer a more robust evaluation of model fit, especially with larger samples where the chi-square test might become overly sensitive. This analysis examines the overall model fit, reliability, validity of the factors, and modifications made to improve the model fit.

**Overall Fit of the Model**
CFA evaluates model fit using several indices:

Fit statistics

| X2 | df | p.value | CFI | TLI | RMSEA | p.value |
|---|---|---|---|---|---|---|
| 256.272 | 127 | 0 | 0.943 | 0.877 | 0.071 | 0.004 |

Confirmatory Factor Analysis tell us how well the measured variables represent the construct and used to confirm or reject the measurement theory.

1. Chi-sq/df = 2.01 (recommended <3 for a good model fit)

2. pvalue for the model = 0 (recommended >.05)*

3. CFI & TLI = 0.94 & 0.87 resp. (recommended >0.8)

4. RMSEA = 0.07 (RMSEA <.05 good; .05-.10 moderate; >.10 bad)

5. p-value (RMSEA) = 0.004 (recommended >.05)*

1. **Chi-Square Test ($\chi^2$/df)**: The chi-square to degrees of freedom ratio ($\chi^2$/df) is a crucial measure of model fit. This study's $\chi^2$/df ratio is 2.01, below the recommended threshold of 3. This suggests a good model fit, indicating that the model is appropriate for the data.

2. **Root Mean Square Error of Approximation (RMSEA)**: The model's RMSEA value is 0.007, falling into the moderate fit range (0.05 to 0.10). Although this is acceptable, a lower RMSEA would indicate a better fit.

3. **Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI)**: The CFI and TLI values are 0.94 and 0.87, respectively. The CFI value exceeds the recommended threshold of 0.90, indicating a good fit. However, while above the 0.80 threshold, the TLI value is still somewhat lower than the ideal value. These indices suggest that the model is reasonably well-fitting but could be improved.

"The chi-square test can be susceptible to sample size, and a significant p-value often reflects the model's inability to reproduce the covariance matrix perfectly. In practical applications, researchers should rely on additional fit indices, such as RMSEA ( or CFI, TLI), to assess model adequacy" (Browne & Cudeck, 1993, p. 145).
The CFA results provide insights into the questionnaire's effectiveness in measuring the intended constructs related to digital tools in education. The moderate RMSEA and the reasonable CFI and TLI suggest that the model fits the data

well. The high factor loadings for critical areas such as **Digital Media Tools** and **Technology Adoption** affirm that these aspects are well-represented in the model.

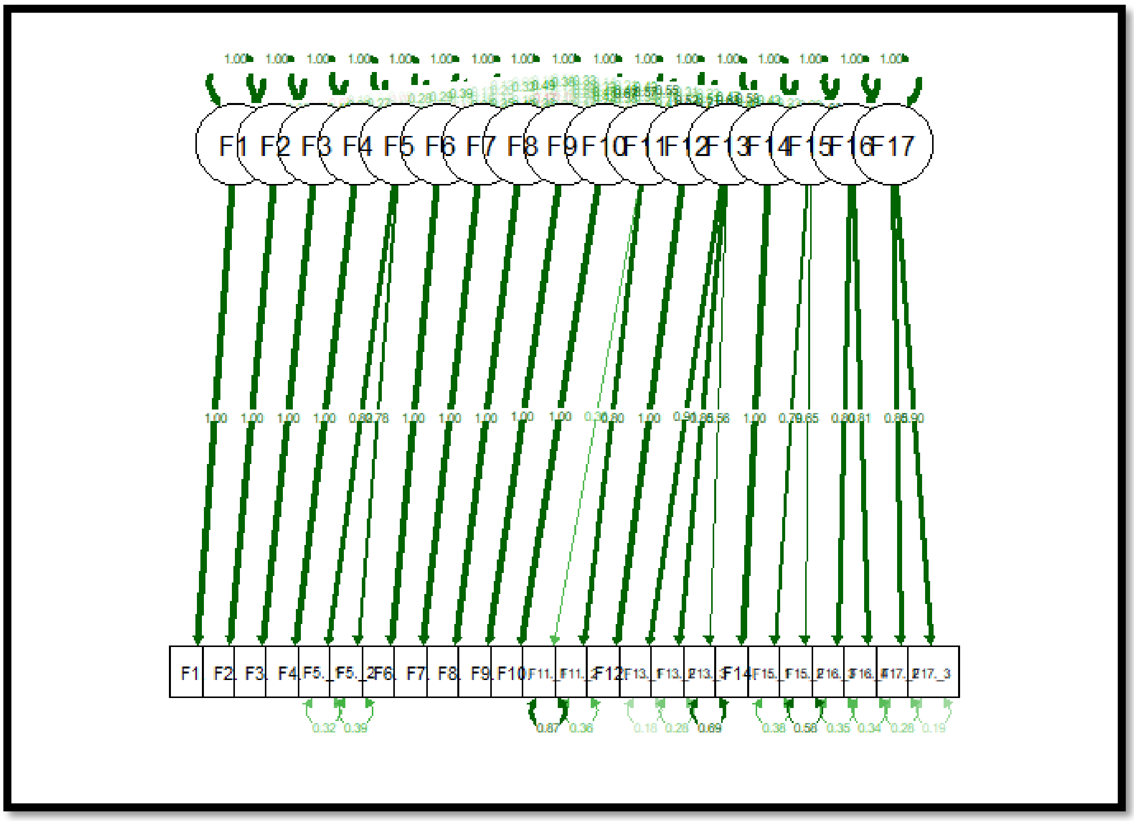


Figure 1.1

Figure 1.1 The CFA results provide insight into the factor structure of the scale and how well the individual items load onto their respective factors. The loading values of items indicate how much each item contributes to the underlying factor it is intended to measure. The **Factor F5 (Digital Media Tools & Technologies)**, **Item F5_1** and **Item F5_2** had loadings of 0.83 and 0.78, respectively. These values indicate strong item loadings, suggesting that both items contribute significantly to the factor. Since both loadings are above 0.5, they are considered satisfactory. **Factor F11 (Higher Education Institutions)** The second item in F11 had a loading of 0.78, which is strong and well above the threshold. **Factor F13 (Preferred Types of Digital Media Tools)** one item had a strong loading of 0.90, which is strongly loading, and the reliability of this factor was good at 0.86. **Factor F14 (Technology Adoption)** the item has a strong loading of (0.66) & **Factor F15 (Technological Infrastructure)** The items in this factor showed moderate loadings, with values of 0.78 and 0.65. Although these values are lower than the ideal range (above 0.8), they are still within an acceptable range. The reliability for this factor was close to 0.6, which indicates that while the factor structure is not perfect, it is reasonable and does not require further revisions at this stage.

The correlation analysis between the developed scale and related constructs provides additional evidence of construct validity. Strong correlations with related constructs support the idea that the scale accurately measures the intended dimensions. The scale showed a significant positive correlation between these two factors, **Digital Media Tools & Technologies and Technology Adoption** supporting the validity of both constructs. This correlation aligns with theoretical expectations, as higher levels of technology adoption are expected to correlate with more extensive use of digital media tools.

A significant positive correlation was also observed between internet connectivity and access to education. This finding is consistent with the notion that better internet connectivity enhances educational access, especially in digital learning

environments. This correlation supports the validity of both constructs and the scale's ability to capture these relationships.
The scale demonstrated a strong correlation between socioeconomic status and technological access, highlighting the digital divide. This correlation confirms the validity of the scale in capturing disparities in access based on socioeconomic factors.

The correlation between **Institutional Support and Higher Education Institutions** constructs was moderate, suggesting that while they are related, the relationship is not as strong as anticipated. This finding indicates that institutional support is a critical factor but may vary widely across higher education institutions, impacting the scale's validity in measuring this construct consistently.

The findings from the construct validity analysis provide valuable insights into the strengths and weaknesses of the developed scale. The strong loadings and correlations observed in maximum factors, such as Digital Media Tools & Technologies and Technology Adoption, support the validity and reliability of the scale. These dimensions are well-captured and can be confidently used in future research. However, certain factors, such as Higher Education Institutions and Institutional Support, showed weaker performance in terms of reliability and item loadings. These findings suggest that the scale is valid & Overall, the construct validity analysis supports the use of this scale for measuring various aspects of Digital Education.

**5. Implications for Educators and Policymakers**

The developed scale offers a valuable tool for educators and policymakers to make informed decisions regarding the selection and utilization of digital tools in the context of quality learning. By utilizing a framework that focuses on evaluating crucial elements such as Digital Media Tools and technologies, Technology Adoption, and Internet Connectivity, decision-making will now be grounded on data. Educators must have the ability to choose tools that are most suitable for their goals and for the learners. The scale's ability to evaluate factors such as the quality of digital tools and institutional support allows for a comprehensive assessment of the digital ecosystem required by higher educational institutions.
Policymakers may enhance the equity and inclusivity of education by prioritizing development in these specific areas. Moreover, the scale's analysis of aspects such as Environmental Impact and Policy Changes can provide valuable guidance for the formulation of sustainable and forward-looking educational policies.

**6. Future Research Directions**

Future research should examine the enduring effects of digital tools on the outcomes of high-quality education, particularly in relation to Sustainable
Development Goal 4 (SDG 4). SDG 4 aims to provide inclusive and equitable education for all, regardless of the quality of education received. Researchers have evaluated the efficacy of digital tools in terms of time, allowing them to provide more comprehensive insights into how these technologies contribute to achieving universal access to quality education.

The emergence of digital technologies, such as artificial intelligence and virtual reality, and their integration in education, is becoming an important area for future research. Examining the results of these technologies in terms of learning and accessibility would greatly assist educators and policymakers in acquiring the necessary abilities to adjust to technological advancements.

**6. Conclusion**

Developing a scale to assess the proficiency of digital tools in providing high-quality education is highly significant. The instrument enables the evaluation of the efficacy of current digital tools and provides insights for future advancements in educational technology. The scale facilitates a more thorough investigation of the correlation between digital tools and SDG 4 by methodically assessing factors such as digital literacy, technology uptake, and educational access. This will serve as a crucial instrument for activities aimed at bridging the digital divide by emphasizing inequalities in access among various socioeconomic categories. Ultimately, the established scale has the capacity to revolutionize educational practices and policies by offering a reliable and accurate assessment of the effectiveness of digital tools. In the present, digital education necessitates innovative approaches, and scalability is a crucial resource in this regard.

It can provide the optimal utilization of digital tools and ultimately contribute to the attainment of universal quality education.

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