Published in final edited form as:

Educ Inf Technol (Dordr). 2018 January ; 23(1): 253–269. doi:10.1007/s10639-017-9599-9.

Development of an instrument to measure Faculty's information and communication technology access (FICTA)

Kamal Ahmed Soomro^{1,2}, Ugur Kale¹, Reagan Curtis¹, Mete Akcaoglu³, and Malayna Bernstein¹

¹Department of Learning Sciences and Human Development, College of Education and Human Services, West Virginia University, Morgantown, WV 26505, USA

²39/B, Hashmat Bano Town, Phuleli, Hyderabad, Sindh 71000, Pakistan

³Department of Leadership, Technology & Human Development, College of Education, Georgia Southern University, Statesboro, GA 30458, USA

Abstract

The phenomenon of “digital divide” is complex and multidimensional, extending beyond issues of physical access. The purpose of this study was to develop a scale to measure a range of factors related to digital divide among higher education faculty and to evaluate its reliability and validity. Faculty's Information and Communication Technology Access (FICTA) scale was tested and validated with 322 faculty teaching in public and private sector universities. Principal components analysis with varimax rotation confirmed an 8-factor solution corresponding to various dimensions of ICT access. The 57-item FICTA scale demonstrated good psychometric properties and offers researchers a tool to examine faculty's access to ICT at four levels – motivational, physical, skills, and usage access.

Keywords

ICT access; Instrument development; Faculty; Digital divide

1 Introduction

With technology as the lynchpin of contemporary society, it is difficult to conceive of any aspect of people's lives that does not rely on it (Cooper 2006). In such a world, people need to engage in technology-supported practices in order to compete with those who use emerging technologies to improve their work and lifestyles. Unfortunately, not everyone has equal access to information and communication technology (ICT). A consequence of this is that people with limited ICT access may not participate in society as effectively as those with better ICT access.

This phenomenon of the “digital divide” refers to the gulf between groups of individuals who have access to ICT and those who do not, and may further exacerbate other divides

(Hameed 2007), including immaterial, material, social, and educational divides (Ghobadi and Ghobadi 2015). In the past, the issue of digital divide was narrowly conceptualized, limited only to physical access to digital technologies, such as computers and the Internet (van Dijk 2005). Digital divide, however, is not a binary matter of physical access, but rather a concern that requires the understanding of other dimensions of access where the divide can occur. van Dijk (2005) has provided a comprehensive theory to understand the phenomenon of digital divide. In his theory of digital divide, *access to ICT* refers to four successive levels of access, namely motivational, physical, skills, and usage access. According to van Dijk, personal and positional categorical inequalities lead to unequal distributions of resources in the society, resulting in unequal access to ICT and limited participation in the society. Thus, understanding digital divide better and minimizing it requires investigating it at all levels of society.

Although digital divide has been investigated in educational settings, it has been handled in limited ways. Typically, educational research has largely focused on students' physical access to ICT in schools and homes (Ritzhaupt et al. 2013). Specifically, studies on higher education faculty's access to various dimensions of ICT as proposed by the new digital divide theory (that considers aspects other than physical access to ICT) do not exist in existing literature. As an initial step to fill the gap in the existing literature, developing instruments to measure the digital divide among higher education faculty in a valid and reliable way is of essence. This paper focuses on the development and validation of such an instrument – Faculty's Information and Communication Technology Access (FICTA) scale focusing on motivational, physical, skills, and usage access.

2 Background and theoretical framework

Today, people are living in the information age, also referred to as the information society, which is associated with modernization and globalization (Alampay 2006). Commonly, diffusion of ICT in the modern society is considered an important indicator of a nation's development and success. It acts as an amplifier of socioeconomic development (Hanafizadeh et al. 2013; Youssef et al. 2013). Physical access to ICT itself does not guarantee development in society, however; more important is people's response once they are provided access to digital technologies (Alampay 2006).

People from all walks of life can play their part toward the development of their society more effectively if they leverage ICT to meaningfully support their work and lives. However, not all people in society use ICT to participate in various aspects of society, due to limited access at various dimensions. The unequal access to ICT creates a complex problem that is known as digital divide.

2.1 Digital divide

The digital divide is a complex and multidimensional issue (Chang et al. 2014). It refers to the gap or space between the subsets of a population who have easy access to ICT, and those who have 'zero' or poor access to modern technologies. With the advent of the World Wide Web and multimedia computers, the issue of digital divide was given much recognition in societies all over the world (van Dijk 2005). This issue has developed into an important area

of concern for over a decade (Ghobadi and Ghobadi 2015). It is generally assumed that bridging the digital gap can improve democracy, education, and economic and social development (Malisuwan et al. 2016).

Although the digital divide is considerable between the developed and developing countries, it exists within developed countries as well. Even the United States, which is considered one of the most modern, advanced, and economically stable countries, is no exception when it comes to digital divide (Goh and Kale 2016; Johnston 2015; Ritzhaupt et al. 2013). van Dijk (2005) argues that most inequalities of access to digital resources are not absolute inequalities showing a gap between 'haves' and 'have nots'; the gap is both relative and diverse. For some, the gap is a matter of physical access, for others, a matter of expertise and usage, and for others, it is a matter of when they adopt new technologies. Research examining the inequalities of access to information and communication technologies indicates that traditional demographic variables such as age, gender, ethnicity, and socioeconomic status are the main factors for the digital gap (Alampay 2006; Ritzhaupt et al. 2013; van Dijk 2005, 2006).

Past literature has defined the term digital divide in three ways 1) physical access to digital technology, 2) use of technology in addition to physical access, and 3) purposes and quality of ICT use side by side to physical access (Hanafizadeh et al. 2013). Most of the old theories concentrate on physical access to digital technologies, presenting a narrow interpretation of the term *access* (van Dijk 2005). Physical access, however, is only one of the many forms of access to ICT, and thus, does not provide a comprehensive approach to understand digital divide (van Dijk 2005).

Hohlfeld et al. (2008) proposed a framework for examining the three successive levels of digital divide within schools – 1) hardware, software, and internet access support for technology, 2) use of technology by teachers and students, and 3) empowerment of students by utilization of these technologies. Although this framework is useful to understand digital divide in school settings, it is not suitable to measure digital divide among faculty for a few reasons. First, its first level focuses on physical access without any examination of users' motivation or mental readiness, which is the prerequisite to adopt and use digital technologies (van Dijk 2005). Second, this framework focuses on students and not teachers, because its third level is directly concerned with the empowerment of students. Third, it does not address 'skills' explicitly, which is one of the key factors influencing the usage.

2.2 Van Dijk's theory of digital divide

van Dijk's (2005) model of successive kinds of access to digital technologies suggests a refined and detailed concept of access to digital technologies, rejecting more narrow conceptualizations of ICT access employed by old theories. It characterizes a comprehensive and theoretically founded attempt to examine the multifaceted phenomenon of digital divide (Lupac and Sladek 2008). His causal model (see Fig. 1) illustrates the relationship among four states of 'affair': 1) Personal and positional categorical inequalities (gender, age, ethnicity, education level, employment status, etc.), 2) Distribution of resources, 3) successive kinds of access to ICT, and 4) Participation in society. Elements 1 and 2 in the model act as the causes, 3 as the phenomenon of the digital divide, and 4 as the possible

consequence or output of the process. *Characteristics of ICT* has been included as a side element that defines the type of inequality to be analyzed.

2.3 Successive kinds of access to ICT

One of the most important characteristics of van Dijk's (2005) core argument is a rectification of the perception of *access* to digital technology. He refined the concept of *access* to ICT by conceptually dividing it into four precise, successive kinds of levels to ICT namely motivational access, material or physical access, skills access, and usage access; where skills access is further divided into operational (instrumental), informational, and strategic skills (van Dijk 2005).

Figure 2 illustrates van Dijk's multifaceted model of access to ICT. He has argued that access problems of ICT progressively shift from the first two stages or kinds of access (physical and motivational access) to the last two (skills and usage access). This model suggests that the digital divide, between two groups or segments of the society, can occur at any one, two, three, or all four stages of access to digital technologies.

2.3.1 Motivational access—Motivational access refers to an individual's wish or intent to “adopt, acquire, learn, and use” digital technologies (van Dijk 2005, p. 27). In other words, it is about the mental readiness of an individual to have and use digital technologies. Lack of motivation in acceptance of emerging technologies has always been on top of the list of problems preventing technology adoption (van Dijk 2012). There are individuals who ‘have-nots’ but also ‘want-nots’ digital technologies, saying various reasons such as they don't need, don't like, aren't able to handle, or don't have time to use these (van Dijk 2005).

In traditional classification, motivation can be classified as intrinsic and extrinsic motivation. Intrinsic motivation refers to “doing something because it is inherently interesting or enjoyable” (Ryan and Deci 2000, p. 55). Or in other words, it is defined as “doing something for its own sake” (Reiss 2012, p.152). Extrinsic motivation, in contrast, is defined as “doing something because it leads to a separable outcome” (Ryan and Deci 2000, p. 55).

To better understand the distinction between the two types of motivation, let us discuss an example. If a kid plays a game, for instance cricket, simply because he or she likes and enjoys playing it, it shows his or her intrinsic motivation to play cricket. On the other hand, if a kid is motivated to play cricket because he or she receives presents or prizes when he or she wins a match; his act is much influenced by extrinsic motivation. These two forms of motivation are not contradictory, and can co-exist most of the time. Researchers have considered the constructs of *perceived enjoyment* and *perceived usefulness* of technology corresponding with intrinsic and extrinsic motivation to technology use respectively (Chang et al. 2014).

2.3.2 Material or physical access—Material or physical access refers to the custody or authorization to use digital technologies. This is the type of access to ICT that has been heavily investigated in past studies. People consider that digital divide can be bridged by providing everyone with a computer and Internet connection (van Dijk 2005). Van Dijk (2005) has asserted that physical access should not be downplayed while emphasizing other

kinds of access. This type of access is very important and an essential condition to develop digital skills and ultimately utilizing ICT to serve various purposes.

2.3.3 Skills access—Skills access denotes an individual's ability to learn, use, and manage digital hardware, software, and Internet connection. van Deursen and van Dijk (2008) have strongly emphasized the levels of digital skills to understand digital divide, focusing on individuals' "can's and can-nots" with digital technologies. According to van Dijk (2005), digital skills do not mean only the ability to operate computers and other related digital technologies but it also includes the skills of searching, selecting, and applying information strategically to promote one's position in the community. He has suggested three successive levels of digital skills: operational skills, informational skills, and strategic skills.

Operational skills: Operational skills, one's ability to operate computer, network and software, is a necessary condition to higher levels of digital skills – informational and strategic skills. These skills involve handling computer files, skills to perform basic operations in word processing, spreadsheets, presentation, media-player and utility software, surfing the Internet, and emailing.

Informational skills: Although operational skills have received much attention, having ability to work with information is indispensable in an information society (van Dijk 2005). van Dijk has defined informational skills as one's ability to search, select, process, and assess information in computer and network resources. As the Internet is the biggest and most widely used source of information nowadays, informational skills are mostly associated with the Internet usage.

Strategic skills: According to van Dijk (2005), strategic skills reflect individuals' capabilities to use computer and network sources as the vehicle to reach specific goals as well as the general goal to promote one's position in the society. Strategic skills are not learned in a formal educational environment or on the work in categorical ways but are assimilated into the day-to-day practices of work, education, and leisure time (van Dijk 2005). However, it is clear that one cannot acquire strategic skills to work with computer and network resources without possessing minimum competence in the two other sets of skills – operational and informational skills.

2.3.4 Usage access—An individual might have fulfilled the minimum requirements of the first three levels – he or she is motivated to possess and use a computer and Internet, has material access to them, and knows how to use them; but nevertheless he or she has "no need, occasion, obligation, time, or effort to actually use them" (van Dijk 2005, p. 95). This level of access implies that individuals actually use digital technologies.

2.4 Need for an instrument to measure Faculty's ICT access

Researchers and educators have recognized the significance of technology in education, particularly to enhance teaching-learning processes (Ertmer et al. 2012; Youssef et al. 2013). Teachers may leverage ICT to support their instructional practices provided they have

adequate access to various dimensions of ICT. They should be motivated to acquire, learn, and utilize technologies, they should have physical access to them at school and home, they should have enough capabilities to use them, and finally they should get opportunity, need, and time to use such technologies.

However, existing literature does not provide sufficient information on teachers' access to ICT at various levels. There is lack of studies answering some important questions. For example, do teachers have adequate ICT access at various levels to support their instructional practices? Where do the gaps exist and where the gaps have closed? In order to have access to the information that answers questions like these, we need tools that can measure digital divide among teachers at various settings in a valid and reliable way.

Goh and Kale (2016) examined West Virginia teachers' ICT access levels (motivation, physical, skills, and usage) based on van Dijk's model. Their study, however, measured teachers' access levels specifically to Web 2.0 resources rather than digital technologies in general, and focused on endogenous motivational (attitude and perceived usefulness), not addressing the element of exogenous motivation (influence by students, peers, and superiors). Further, they did not concentrate on specific kinds of skills access namely operational, informational, and strategic skills (van Dijk 2005). Therefore, using van Dijk's model as the basis, this study focuses on the development and testing the validity of a new survey instrument measuring faculty's access to motivational, physical, skills, and usage access to ICTs.

3 Methods

In an effort to measure faculty's access to ICT at four levels (motivational, physical, skills, and usage access), a survey instrument, the FICTA scale consisting of primarily Likert scale and checklist items was developed. We took several steps to affirm that the tool being developed meets adequate standards of validity and reliability.

3.1 Participants

A total of 322 faculty members at public and private universities in Pakistan completed the survey. The participants came from a mix of academic disciplines. They were holding various teaching positions including lecturer ($n = 107$, 33.2%), senior lecturer ($n = 34$, 10.6%), assistant professor ($n = 120$, 37.3%), associate professor ($n = 50$, 15.5%), and professor ($n = 11$, 3.4%). Their age ranged from 27 to 57 years with the average age of 38.58 years. Other characteristics of the participants are summarized in Table 1.

3.2 Item generation

The construction of the FICTA scale began with the process of reviewing the literature and examining the available instruments on the topic. A pool of 74 items was initially generated that addressed various dimensions of ICT access. Many of the items were identified and selected from existing scales (Goh and Kale 2016; Kale and Goh 2014; Safdar et al. 2011; van Deursen et al. 2012).

3.2.1 Motivational access—In order to have more explanative understanding of motivational access to ICT, the measurement of this construct in the present instrument included two different aspects: *Endogenous Motivational Access*, and *Exogenous Motivational Access*. Endogenous motivational access refers to an individual's desire to adopt ICT that originates from *the inside* of the individual, and is not directly affected by external sources. In this manner, an individual would be endogenously motivated if he or she adopts and utilizes ICT simply because of his or her own perceptions and beliefs that he or she will enjoy using them, or benefit from them in some way. On contrast, exogenous motivational access takes focus on external and other contextual aspects into account. It denotes an individual's desire to adopt ICT that originates from the outside sources including social influence, time, and material resources, rather than individual's own beliefs and perceptions.

This approach to view motivational access allows to include aspects of different constructs, which would enhance the focus of traditional classification of motivation. Perceived enjoyment, perceived usefulness, and perceived ease of use belong to endogenous motivation; because they are directly related with the individuals own beliefs, and are not influenced by outside factors. On the other hand, peer-influence, superior-influence, and facilitating conditions belong to exogenous motivation, because they are indicators of the influence of outside environment, and are not directly related with individual's own beliefs.

Therefore, to measure faculty's motivation to adopt digital technologies, participants were asked two sets of items focusing on their endogenous motivational access and exogenous motivational access. These two constructs mainly consisted of newly generated items. However, these items were inspired by other constructs, such as perceived ease of use, perceived usefulness, peer influence, superior influence, and facilitating conditions, used in different studies (Ajjan and Hartshorne 2008; Sadaf et al. 2012; Taylor and Todd 1995). Items in these two constructs were inspired from different constructs used in other studies because they fit our definitions for the two constructs. Each item within these two sub-constructs was formatted on a 5-point scale (from 1 = strongly disagree to 5 = strongly agree), with a higher score indicating a higher level of motivational access.

3.2.2 Physical access—Physical access is probably the most important dimension to understand the problem of digital divide. However, its measurement is potentially more direct and tangible in comparison to the measurement of other dimensions of ICT access. Therefore, it was measured with the help of checklist items rather than a Likert scale measurement. Previous studies have adopted a similar method to measure this construct (Goh and Kale 2016; Kale and Goh 2014). A list of digital devices and resources taken from existing research (Goh and Kale 2016) was provided to the participants, and they were asked if they had access to these devices at home or on campus.

3.2.3 Skills access—We followed van Dijk's (2005) classification of skills access – operational, informational, and strategic skills. Items for skills access are intended to measure self-assessment of skills access by the respondents. These items were drawn from an existing survey instrument on internet skills (van Deursen et al. 2012) with some minor

changes. These items were formatted on a 5-point Likert scale (ranging from 1 = strongly disagree to 5 = strongly agree), with a higher score indicating a higher level of skills access.

3.2.4 Usage access—With regard to higher education faculty's usage access, we can classify their ICT usage in two categories: *General Usage Access*, and *Instructional Usage Access*. The general usage access includes utilization of various ICTs to cope with a variety of tasks associated with one's life, which are not directly related to faculty's primary professional responsibilities – instructional practices. It may include activities related with communication, entertainment, office work, financial transactions, and social interactions. On the other hand, instructional usage access indicates faculty's ICT usage to support their instructional practices. It includes faculty's technology supported practices for planning and preparation of instruction, delivering learning content, enhancing teaching-learning process, and assessing students' learning.

Most of the items for general usage access were drawn afresh in the light of van Dijk's (2005) definition of usage access. However, items measuring instructional usage access were adapted from existing literature (Kale and Goh 2014; Safdar et al. 2011) with some changes. These items were formatted on a 5-point Likert scale (ranging from 1 = Never to 5 = Very often), with a higher score indicating a higher level of usage.

3.3 Procedures

The development and testing of FICTA scale involved a number of stages: selection and creation of items, content validity, discriminant validity, cognitive interview, field-testing, factor structure, and assessment of reliability. We employed a self-administered paper survey to record participants' responses. The questionnaire consisted of 63 items measuring respondents' access to ICT at the four levels. The participants were approached by employing the mix of purposive and convenience sampling.

4 The survey validation process

4.1 Content validity of the provisional tool

Content validity is the indication that the items in the scale sample the thorough range of the attribute under investigation (DeVon et al. 2007). We followed a quantitative approach suggested by Lawshe (1975) to perform the content validity of the 74-item provisional tool. A total of five experts were identified and approached for the purpose of content validity of the tool. The experts were invited to the online content validity questionnaire, where they were requested to review the potential scale items by rating each item on a three-point scale (1 = not essential, 2 = useful but not essential, and 3 = essential) under definition of each construct, confirming if those items were suitable and necessary indicators of the construct. Upon completion of questionnaires, the content validity ratio (CVR) for each item was calculated. The items that were not significant at 0.05 level were eliminated from the tool. In the result of content validation of the items, a total of 66 items were found to be worthy of retention.

4.2 Discriminant validity

Discriminant validity is the scale's capability to differentiate or discriminate between constructs showing the correct pattern of relationship with other variables. In order to establish the discriminant validity of FICTA scale, a confirmatory Q-sorting procedure was adopted (Zait and Berteau 2011). To implement the Q-sorting procedure, four potential participants participated in an online questionnaire consisting of 66 items. The questionnaire provided the participants nine boxes representing eight constructs within the scale and an extra category labeled as "does not match with any category". Respondents were directed to classify items into these nine categories by drag and drop procedure. Only two items were found to mismatch with their corresponding categories by two participants. We dropped those two items, and retained 64 items that were correctly classified by all four participants.

4.3 Retrospective interviewing

Cognitive interviewing is considered an essential part of developing a survey instrument (Haeger et al. 2012). It is intended to assess the soundness of the survey questions. For this purpose, we used retrospective method (Dillman and Redline 2004) to think aloud technique with four participants. We preferred this method because it allows evaluating the survey in a way respondents naturally read the questionnaire. The participants were first asked to complete the survey questionnaire naturally as they would do it alone, ignoring the presence of one of the authors. While they were completing the questionnaire, the cognitive interviewer observed the answering process, noting if the respondent looked bewildered at any point, flipped pages back and forth, or made any alteration, and other noticeable indicators of problems. After the respondents had completed the questionnaire, the interviewer asked participants questions about their understanding of items, and their behavior evoked while they were completing the questionnaire.

The problems identified in the result of cognitive interview procedure were mainly about some confusing terms used in the items, which were resolved accordingly. This exercise also allowed estimating the time required to complete the questionnaire. On average, the four participants took 17 min to complete the questionnaire including the six demographic items. Considering the participants' feedback on length of the questionnaire, it was felt appropriate to once again review the questionnaire and truncate it a bit if possible. This review resulted in removal of only one item, leaving a 63-item scale for the field test of the instrument.

4.4 Factor structure

After the instrument has been field tested with 322 participants, a principal component analysis (PCA) with varimax rotation was applied to the collected data to confirm various sub-constructs within the FICTA scale. This analysis included all 50 items within seven sub-constructs including endogenous motivation, exogenous motivation, operational skills, informational skills, strategic skills, general usage, and instructional usage. However, 13 items measuring physical access were not included in the analysis due to their different format i.e., checklist format that can only record two values ('yes' or 'no'), rather than Likert scale with five points items on the rest of sub-constructs.

Initially, PCA revealed twelve components with eigen values of 1.0 or more. Factor loadings did not show meaningful groupings of few items. The twelve components accounted for 72.77% of cumulative variance. Out of the 72.77% of cumulative variance, the first seven components accounted for 50.33 of cumulative variance. The remaining five components altogether accounted for 12.42% of variance, with none of the component contributing more than 3% of variance. A closer look on the scree plot supported our assumption for seven components. So, we decided to go for a seven factor solution.

On the second step, PCA using varimax rotation forcing a seven factor solution was performed. A minimum item loading of 0.4 was specified in this step. A seven-component solution was reached with most meaningful item groupings (see Table 2). However, six items (Item# 18, 23, 31, 37, 52, and 56) with loadings less than 0.4 did not load on any component. Their lower loadings indicated that they may have been ambiguous to participants, resulting in a lack of a pattern in participants' responses. Therefore, they were removed from the scale, leaving 44 items for the seven sub-constructs, and 57 items (including 13 items for physical access) for the whole scale with eight sub-constructs.

Note. Loadings from a Principal Component Analysis with Varimax rotation. Items having inadequate loadings are highlighted with a '*' with their numbers.

a. Rotation converged in 7 iterations.

4.5 Reliability analysis

Confirmation of the validity and reliability of the instrument is a prerequisite for assuring the integrity of research findings (DeVon et al. 2007). It determines how well the items on a scale fit together conceptually (DeVon et al. 2007). Internal consistency reliability analysis of the FICTA scale resulted in a Cronbach's coefficient α of .868 for the total scale, and the coefficient α for the eight constructs ranged from .680 to .885 (see Table 3 for details).

5 Discussion

The process of developing the FICTA scale was stretched on various stages aiming to produce a valid and reliable scale. After the field test with 322 faculty participants, principal component analysis was performed to confirm various sub-constructs within the scale. Though the process of factor-confirmation led to removal of six items, with low loadings, from the scale, it did not cause removal of any essential content from the scale. DeVon et al. (2007) has recommended keeping the instrument as concise as possible without yielding needed content for increased reliability of the tool. Most factor loadings on the retained items were high (i.e., > 0.6), and the lowest loadings were adequate enough to be included in the factor. Dropping the six items helped to shorten the scale, which also resulted in the increased reliability of the scale, leaving the enhanced version of the FICTA scale consisting on eight sub-constructs with 57 items (see Table 3).

Our analyses demonstrated that the 57-item FICTA scale had good reliability and satisfactory validity. Findings, from both the reliability test and PCA confirming internal consistency of measures and construct validities – convergent and discriminant validity, suggest that it is appropriate to create aggregated measures by averaging the means of all

items of each construct. The reliability test demonstrated that the 57-item FICTA scale had excellent reliability ($\alpha = .868$). Seven out of eight constructs of FICTA scale also showed very good internal consistency with Cronbach's alpha ranging from .800 to .885 (see Table 3). The only construct that did not show outstanding reliability was physical access ($\alpha = .680$).

The low reliability of the physical access could be because of its format, i.e., checklist of items, rather than a Likert scale as used in other seven constructs of the scale. Most of the devices listed in the construct of physical access are complementary to each other. However, some devices may be considered redundant to each other. For example, desktop computer, laptop, and tablet have almost similar functions. Similarly, an individual might have access to web cam as a separate device or as a built-in part of a modern laptop or tablet. Although removal of any item within the construct of physical access did not help to increase the reliability of the construct with the current data, it would be worthwhile to ponder how the list of devices can be improved in future studies. Addition of some Likert scale items, to the checklist of items in the construct, also may help to increase the reliability of the construct.

One of the primary limitations of the instrument presented here is that it relies on respondents' self-reported data to estimate their access to ICT. Due to social desirability of giving positive responses, participants may not reflect the true picture of their ICT access, particularly while recording their skills access. Probably the best way to measure participants' digital skills is to conduct performance tests. But performance tests are very difficult to administer and require lots of resources and time. They are less suitable for large-scale surveys (van Deursen et al. 2014). They may also not be feasible for faculty participants who seem to be very busy in their teaching and research assignments.

Also, the sample used in this study belonged to particular geographical setting – Pakistan. Therefore, researchers need to confirm scale reliability of the tool for all sampled populations. Although the tool presented here was specifically designed for higher education faculty, the tool may be helpful to capture ICT access of teachers at different settings with some changes. Future work is recommended to work on similar scales to measure ICT access of teachers working in other educational settings such as K-12.

6 Conclusion

The present study reports on development and validation of FICTA scale to measure faculty's access to ICT in terms of their motivation, physical, skills, and usage access. The recommended scale consists of 57 items within eight dimensions of ICT access—endogenous motivational access, exogenous motivational access, physical access, operational skills, informational skills, strategic skills, general usage, and instructional usage. The scale has good psychometric properties, and offers researchers a tool that captures faculty's access to ICT at the four levels – motivational, physical, skills, and usage access. The instrument will help to study the issue of digital divide among higher education faculty.

References

- Ajjan H, Hartshorne R. Investigating faculty decisions to adopt web 2.0 technologies: Theory and empirical tests. *The Internet and Higher Education*. 2008; 11(2):71–80.
- Alampay E. Beyond access to ICTs: Measuring capabilities in the information society. *International Journal of Education and Development using ICT*. 2006; 2(3):4–22.
- Chang Y, Wong SF, Park MC. A three-tier ICTaccess model for intention to participate online a comparison of developed and developing countries. *Information Development*. 2014
- Cooper J. The digital divide: The special case of gender. *Journal of Computer Assisted Learning*. 2006; 22(5):320–334.
- DeVon HA, Block ME, Moyle-Wright P, Ernst DM, Hayden SJ, Lazzara DJ, et al. A psychometric toolbox for testing validity and reliability. *Journal of Nursing Scholarship*. 2007; 39(2):155–164. [PubMed: 17535316]
- Dillman, DA., Redline, CD. Testing paper self-administered questionnaires: Cognitive interview and field test comparisons. In: Presser, S.Rothgeb, JM.Couper, MP.Lessler, JT.Martin, E.Martin, J., Singer, E., editors. *Methods for testing and evaluating survey questionnaires*. Hoboken: Wiley & Sons, Inc.; 2004. p. 299–317.
- Ertmer PA, Ottenbreit-Leftwich AT, Sadik O, Sendurur E, Sendurur P. Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education*. 2012; 59(2):423–435.
- Ghobadi S, Ghobadi Z. How access gaps interact and shape digital divide: A cognitive investigation. *Behaviour & Information Technology*. 2015; 34(4):330–340.
- Goh D, Kale U. The urban–rural gap: Project-based learning with web 2.0 among West Virginian teachers. *Technology, Pedagogy and Education*. 2016; 25(3):355–376.
- Haeger, H., Lambert, AD., Kinzie, J., Gieser, J. Using cognitive interviews to improve survey instruments. Paper presented at the annual forum of the Association for Institutional Research; New Orleans. 2012. <http://cpr.indiana.edu/uploads/AIR2012%20Cognitive%20Interviews.pdf>
- Hameed, T. ICT as an enabler of socio-economic development. Paper presented at the Digital Opportunity Forum; Seoul. 2007. <http://unpan1.un.org/intradoc/groups/public/documents/undpadm/unpan043799.pdf>
- Hanafizadeh MR, Hanafizadeh P, Bohlin E. Digital divide and e-readiness: Trends and gaps. *International Journal of E-Adoption (IJEa)*. 2013; 5(3):30–75.
- Hohlfeld TN, Ritzhaupt AD, Barron AE, Kemker K. Examining the digital divide in K-12 public schools: Four-year trends for supporting ICT literacy in Florida. *Computers & Education*. 2008; 51(4):1648–1663.
- Johnston T. Training teachers to bridge the digital divide. *The William and Mary Educational Review*. 2015; 3(2):15–17.
- Kale U, Goh D. Teaching style, ICT experience and teachers' attitudes toward teaching with web 2.0. *Education and Information Technologies*. 2014; 19(1):41–60.
- Lawshe CH. A quantitative approach to content validity. *Personnel Psychology*. 1975; 28(4):563–575.
- Lupac P, Sladek J. The deepening of the digital divide in the Czech Republic. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace*. 2008; 2(1)
- Malisuwan S, Kaewphanuekrungsi W, Milindavanij D. Digital divide in Thailand: Analysis and recommendations. *International Journal of Advanced Research in Engineering and Technology*. 2016; 7(1):41–46.
- Reiss S. Intrinsic and extrinsic motivation. *Teaching of Psychology*. 2012; 39(2):152–156.
- Ritzhaupt AD, Liu F, Dawson K, Barron AE. Differences in student information and communication technology literacy based on socio-economic status, ethnicity, and gender: Evidence of a digital divide in Florida schools. *Journal of Research on Technology in Education*. 2013; 45(4):291–307.
- Ryan RM, Deci EL. Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology*. 2000; 25(1):54–67. [PubMed: 10620381]
- Sadaf A, Newby TJ, Ertmer PA. Exploring factors that predict preservice teachers' intentions to use web 2.0 technologies using decomposed theory of planned behavior. *Journal of Research on Technology in Education*. 2012; 45(2):171–196.

- Safdar, M., Hussain, I., Malik, MA., Masood, K., Yaqoob, M. Challenges of information era: Teachers' attitude towards the use of internet technology. Paper presented at the International Arab Conference on Information Technology; 2011. <http://212.138.128.45/handle/123456789/55510>
- Taylor S, Todd P. Decomposition and crossover effects in the theory of planned behavior: A study of consumer adoption intentions. *International Journal of Research in Marketing*. 1995; 12(2):137–155.
- van Deursen, AJAM., Helsper, EJ., Eynon, R. Measuring digital skills: From digital skills to tangible outcomes project report. 2014. http://doc.utwente.nl/92924/1/Measuring_Digital_Skills.pdf
- van Deursen, AJAM., van Dijk, JAGM. Measuring digital skills: Performance tests of operational, formal, information and strategic internet skills among the Dutch population. Paper presented at the 58th conference of the International communication association; Montreal. 2008.
- van Deursen AJAM, van Dijk JAGM, Peters O. Proposing a survey instrument for measuring operational, formal, information, and strategic internet skills. *International Journal of Human-Computer Interaction*. 2012; 28(12):827–837.
- van Dijk, JAJGM. The deepening divide: Inequality in the information society. Thousand Oaks: Sage Publications; 2005.
- van Dijk JAGM. Digital divide research, achievements and shortcomings. *Poetics*. 2006; 34(4):221–235.
- van Dijk, JAGM. The evolution of the digital divide: The digital divide turns to inequality of skills and usage. In: Bus, J.Crompton, M.Hildebrandt, M., Metakides, G., editors. *Digital enlightenment yearbook*. Vol. 2012. 2012. p. 57-75.
- Youssef AB, Dahmani M, Omrani N. Information technologies, students' e-skills and diversity of learning process. *Education and Information Technologies*. 2013; 20(1):141–159.
- Zait PA, Berteau PSPE. Methods for testing discriminant validity. *Management & Marketing Journal*. 2011; 9(2)

Note: ICT indicates information and communication technology

Fig. 1.
A causal model of the core argument (van Dijk 2005, p. 15)

Fig. 2.

A cumulative and recursive model of successive kinds of access to digital technologies (van Dijk 2005, p. 22)

Table 1

Participant Characteristics

Variable	n (%)
Gender	
Male	214 (66.5%)
Female	108 (33.5%)
Type of university	
Public Sector	226 (70%)
Private Sector	96 (30%)
Teaching Experience	
0 to 5 years	80 (24.8%)
6 to 10 years	123 (38.2%)
11 to 15 years	75 (23.3%)
16 to 20 years	40 (12.4%)
21 to 25 years	2 (0.6%)
More than 25 years	2 (0.6%)

Table 2

Factor Structure of the FICTA scale

Item	Operational Skills	Instructional Usage	Informational Skills	General Usage	Strategic Skills	Exogenous Motivation	Endogenous Motivation
#14.							.724
#15.							.823
#16.							.777
#17.							.763
#18.*							
#19.						.842	
#20.						.826	
#21.						.835	
#22.						.809	
#23.*							
#24.	.626						
#25.	.709						
#26.	.774						
#27.	.756						
#28.	.682						
#29.	.757						
#30.	.746						
#31.*							
#32.			.672				
#33.			.662				
#34.			.735				
#35.			.551				
#36.			.723				
#37.*							
#38.			.588				
#39.					.684		
#40.					.743		
#41.					.689		

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Item	Operational Skills	Instructional Usage	Informational Skills	General Usage	Strategic Skills	Exogenous Motivation	Endogenous Motivation
#42.					.729		
#43.					.718		
#44.					.656		
#45.				.537			
#46.				.677			
#47.				.591			
#48.				.675			
#49.				.706			
#50.				.632			
#51.				.683			
#52.*							
#53.				.570			
#54.		.531					
#55.		.674					
#56.*							
#57.		.601					
#58.		.758					
#59.		.569					
#60.		.620					
#61.		.434					
#62.		.636					
#63.		.666					

Table 3**57-item FICTA scale ($\alpha = .868$)****Physical Access ($\alpha = .680$)**

1. Desktop computer
2. Laptop computer
3. Broadband/DSL internet
4. USB Flash drive (memory stick)
5. Smartphone (cell phone internet functionality)
6. iPad/Tablet
7. Webcam
8. Printer
9. Office Software Suit (e.g., Microsoft Office, Open Office)
10. Photo editing software (e.g. Adobe Photoshop, Corel Paint)
11. Video editing software (e.g. iMovie, Movie Maker)
12. Statistical Software (e.g., SPSS, SAS)
13. Learning Management System (e.g., Blackboard, eCampus)

Endogenous Motivational Access ($\alpha = .806$)

14. Using the Internet can provide me with information that would lead to better decisions.
15. Using ICT will be of no benefit to me.
16. Using computer and Internet can improve my work performance.
17. Using Computer and the Internet seem to be enjoyable.

Exogenous Motivational Access ($\alpha = .881$)

18. Seeing other teachers using Computer and the Internet inspires me.
19. I want to use ICT because my superiors expect me to use it.
20. I wish to use computer and the Internet because my students think that I should use them.
21. I am interested to adopt digital technologies because my university provides enough technology support.

Operational Skills Access ($\alpha = .885$)

22. I feel comfortable in creating and editing a text file in a word processing program.
23. It is easy for me to create a computer presentation.
24. I feel difficulty to change some basic computer settings (wallpaper, time/date, sounds etc.).
25. I can save images and text from the website on the hard disk.
26. I feel confident to download programs from the internet.
27. I can send an attachment with an email.
28. I know enough about transferring files from hard disk to a USB flash drive and vice versa.

Informational Skills Access ($\alpha = .853$)

29. I always know what search terms to use when searching the internet.
30. I can use advance search options to reach my required information.
31. I feel confident to evaluate the sources of the information found on the Internet.
32. I feel comfortable to synthesize online information.
33. It is easy for me to retrieve a Website on the Internet.
34. I can easily choose from search results.

Strategic Skills Access ($\alpha = .820$)

35. I can make a choice by consulting the Internet.
36. I can reach my intended goal while using the Internet.
- Educ Inf Technol
37. On the Internet, it is easy for me to work toward a specific goal.
38. I can gain benefits from using computer and the Internet.
39. Using various ICT tools, I feel confident in achieving my goals.
40. I feel confident in making important decisions with the help of the Internet.
- General Usage Access ($\alpha = .800$)
41. I search the information of my interest on the Internet.
42. I use ICT to support my research activities.
43. I use emails as one of the primary means of communication.
44. I make voice/video calls via the Internet.
45. I create letters, reports and/or papers on computer.
46. I prepare presentations on computer.
47. I store and manipulate data in a spreadsheet program.
48. I use digital technologies to watch movies or television programs.
- Instructional Usage Access ($\alpha = .815$)
49. I use ICT for communication about assignments among students.
50. I use ICT for enhancing students' content learning.
51. I use ICT for facilitating students' group work.
52. I use ICT to improve students' problem solving skills.
53. I use digital technologies for the delivery of my instruction.
54. I use digital technologies to communicate with students.
55. I prepare learning materials using computer and internet resources.
56. I develop critical thinking skills among students with the help of ICT.
57. I use ICT to encourage peer-feedback among my students.
-