The development of a Thurstone scale for identifying teacher ability in using information and communication technology

A Arfandi[1], Purnamawati[1] and Nurfaedah[1]

[1]Universitas Negeri Makassar, Makassar (Indonesia)

E-mail: anas.arfandi@unm.ac.id

Abstract. Teachers in Indonesia should not only mastery the four competencies (pedagogy, professional, personality, and social). They also must be able to use information technology in the learning process especially in the 4.0 industrial revolution. An instrument to measure the capability of the teacher in using information technology was developed. This article uses the Thurstone Scale as a methodological basis for identifying what capabilities are approved by experts in measuring the ability of teachers in use information and communication technology (ICT) in the learning process in vocational high schools. There are 30 (thirty) statements has analysed, 26 items were Valid in 0.01 significant level, and 4 items were Valid in 0.05 significant level. The instrument developed has good characteristics and all of the statement items meet the valid category with a very good level of reliability. Therefore, all instrument has met the validity and reliability criteria, the instrument will use to measure the ability of teacher in using information and communication technology.

1. Introduction

The presence of the Industrial Revolution 4.0 that replaced the industry 3.0 was characterized by cyber physical and manufacturing collaboration as a challenge for teachers in vocational schools and prospective teacher education for vocational education. The technological developments occurred forced various industries to start touching the virtual world. Human, machine, and data connectivity is one of the characteristics of the 4.0 industrial revolution better known as the internet of things (iot). Facing this requires a variety of preparations and strategies for teachers to deliver learning to students, especially in vocational education [1].

Vocational education and training is an educational approach that emphasizes the needs of the industry so that individual improvement and development can be done in the industry [2]. Strengthening the four elements in the education system requires a new movement to respond to the industrial era 4.0. One of the movements proclaimed by the government was a new literacy movement as a reinforcer and even shifted the old literacy movement. The new literacy movement is intended to focus on three main literacies namely, 1) digital literacy, 2) technology literacy, and 3) human literacy). These three skills are predicted to be skills that are needed in the future or in the industrial era 4.0. [3, 4].

Teacher education for vocational education must be able to bridge the gap between the world of education and the industrial world. In vocational education, the industrial movement should be followed in the classroom learning process at the vocational high school. The educational process in the industrial revolution 4.0 harmonized humans and machines to solve various problems faced. In

addition, the alignment also encourages the creativity of students and triggers new innovations to improve human life in the future [5].

Utilizes Information Communication and Technology (ICT) optimally in learning will be able to improve student learning achievement [6]. Learning by integrating ICT can facilitate teachers and students to learn dynamically and interactively. It provides opportunities for student achievement. In addition, students can easily search for teaching materials if they use ICT [7].

The development of ICT can provide new opportunities for the world of education to be able to develop new learning models to cover weaknesses that arise from the implementation of learning that has been applied so far. One of the efforts that has been proclaimed by the government is implementation of ICT Based School Management and ICT Based Learning which is expected to improve school services for all its citizens. The aim of the program is to improve the quality of graduates who are able to compete in higher education or in the industrial world [6, 8].

This research was conducted to describe the use of ICT in the learning process. Before measuring the teacher's ability to use ICT in the learning process, a standardized instrument will be developed that meets the validity and reliability of measurement. Therefore, this study purported to develop an instrument to measure teacher's ability to utilize ICT in the learning process.

2. Methodology

The instruments compiled are attributes of the use of ICT in learning. This method is oriented to scaling the stimulus to determine the location of the continuum. The scale used in the instrument is the Thurstone scale. Mueller [9] states that Thurstone has three scale techniques, but the one used in this study is the method of equal appearing intervals. The Thurstone scale interval continuum used is 1 - 11. Thurstone makes a measuring instrument with an interval scale, so each item has a different score but the score distance between items is the same. The use of the Thurstone scale refers to [10]–[12]

Construction of the item statement based on the instrument grille. Each item then validate by content validity. This is meant whether the items made reflect the intended indicator. This validation is a test of the item statement with rational analysis through expert judgment. The experts as respondent who rate are 63 people consists of lecturers who are experienced in teaching ICT-based learning media and teachers who are experienced in using ICT in learning. Instrument testing was conducted by judges with 63 people with details as follows: 24 lecturers and 39 teachers.

The test results were analyzed to determine the construct validity of the instrument using moment product correlation analysis. After Validity test, the items were measure by reliability test. Reliability coefficient shows the consistency of scores on the same subject, when tested again with the same test on different occasions or with an equivalent test. Thus, reliability shows a consistency of the results obtained by respondents on several occasions testing. Reliability testing uses the Cronbach Alpha reliability coefficient.

3. Result and Discussion

The development of the instrument begins with the preparation of the statement item instrument grille based on the use of ICT variables in learning. The statement is divided into 3 aspects, namely: a) aspects of understanding as many as 7 (seven) items statement, b) aspects of the use of media directly (offline), c) aspects of the use of media in the network (online). The instrument for using ICT in learning refers to several articles [13]–[15]. In addition, instrument development also refers to various articles on industry 4.0 [1], [5], [16], [17]. The formulation of the statement made consists of 30 items, which will then be submitted to experts as respondents.

Table 1. List of item statements

Construct	Item
Teacher Understanding on ICT	Understanding various ICT input hardware (keyboard, mouse, microphone, etc.)
	Understand various ICT Process hardware (e.g. CPU, Memory, Processor, etc.)
	Understand various ICT Output hardware (e.g. Monitor, Printer, LCD, etc.)
	Understanding databases
	Understand programming languages (e.g. Visual basic, Fortran, etc.)
	Understanding artificial intelligence
	Understanding Virtual Classes
Using offline ICT	Word processing software (e.g. Word, etc.)
	Number processing software (e.g. Excel, etc.)
	Presentation software (e.g. PowerPoint, etc.)
	Graphic design software (e.g. Corel Draw, etc.)
	Image processing software (e.g. Paint, etc.)
	Mind map software
	Using the LCD Projector
	Able to manage files and folders on the computer
	Make learning videos (e.g. Camtasia, etc.)
	Installing the software
	Uninstall software
	Solve problems on the Projector LCD display
Using online ICT	Able to use Local Area Network (LAN) facilities
	Able to use Hotspot facilities
	Using e-mail (email)
	Able to use search engines (e.g. google, opera, etc.)
	Able to use online learning facilities (e.g. Moodle, Edmodo, etc.)
	Able to store data online (e.g. google drive, my drive, etc.)
	Able to share data online (e.g. share, etc.)
	Arrange online learning material
	Configure online learning videos (YouTube)
	Using database
	Use various facilities on a smart phone

Table 1 shows the developed statement items. Respondents were asked to choose one of the numbers from the range of 1 to 11. The higher the number chosen, means the more items needed to measure the teacher's ability to use ICT in learning. Respondents who gave questionnaires were 28 experts who had teaching experience under 5 years, 16 experts who had up to 10 years experienced, and 19 experts with more than 10 years experienced. Recapitulation of responses from Experts is outlined in Table 2.

Table 2. Percentage Category of Item Statement

Construct	Item	Necessary	Need	No Need
Teacher Understanding on ICT	Understanding various ICT input hardware (keyboard, mouse, microphone, etc.)	96.77	0.00	3.23
	Understand various ICT Process hardware (e.g. CPU, Memory, Processor, etc.)	93.55	3.23	3.23
	Understand various ICT Output hardware (e.g. Monitor, Printer, LCD, etc.)	96.77	3.23	0.00
	Understanding databases	90.32	6.45	3.23
	Understand programming languages (e.g. Visual basic, Fortran, etc.)	90.32	0.00	9.68
	Understanding artificial intelligence	87.10	6.45	6.45
	Understanding Virtual Classes	93.55	6.45	0.00
Using offline ICT	Word processing software (e.g. Word, etc.)	100.00	0.00	0.00
	Number processing software (e.g. Excel, etc.)	100.00	0.000.	0.00
	Presentation software (e.g. PowerPoint, etc.)	100.00	00	0.00
	Graphic design software (e.g. Corel Draw, etc.)	90.32	9.68	0.00
	Image processing software (e.g. Paint, etc.)	93.55	6.45	0.00
	Mind map software	90.32	6.45	3.23
	Using the LCD Projector	100.00	0.00	0.00
	Able to manage files and folders on the computer	100.00	0.00	0.00
	Make learning videos (e.g. Camtasia, etc.)	96.77	3.23	0.00
	Installing the software	96.77	3.23	0.00
	Uninstall software	96.77	3.23	0.00
	Solve problems on the Projector LCD display	96.55	3.45	0.00
Using online ICT	Able to use Local Area Network (LAN) facilities	100.00	0.00	0.00
	Able to use Hotspot facilities	100.00	0.00	0.00
	Using e-mail (email)	100.00	0.00	0.00
	Able to use search engines (e.g. google, opera, etc.)	100.00	0.00	0.00
	Able to use online learning facilities (e.g. Moodle, Edmodo, etc.)	100.00	0.00	0.00
	Able to store data online (e.g. google drive, my drive, etc.)	96.77	3.23	0.00
		96.77	3.23	0.00
	Able to share data online (e.g. share, etc.)	96.77	3.23	0.00
	Arrange online learning material	93.55	6.45	0.00
	Configure online learning videos (YouTube)	93.55	6.45	0.00
	Using database	96.77	3.23	0.00
	Use various facilities on a smart phone			

The categories in Table 2 refer to the ideal formula. The maximum value of the data is 11 and the minimum value is 1. An ideal mean is 6, and ideal deviation standard is 1.67. Based on that value, if the choice of respondents is greater than 7.67, the choice of respondents is in the Necessary category. If the respondent's choice is in a number greater than 4.33 but smaller or equal to 7.67, the choice of

the respondent is in the Need category. If the respondent's choice is smaller than 4.33, the choice of respondent is in the No Need category [18].

Table 3. Validated item statement

Construct	Item	R value	R Table	Significant
Teacher Understanding on ICT	Understanding various ICT input hardware (keyboard, mouse, microphone, etc.)	0.698**	0.250	Valid
	Understand various ICT Process hardware (e.g. CPU, Memory, Processor, etc.)	0.802**	0.250	Valid
	Understand various ICT Output hardware (e.g. Monitor, Printer, LCD, etc.)	0.681**	0.250	Valid
	Understanding databases	0.890**	0.250	Valid
	Understand programming languages (e.g. Visual basic, Fortran, etc.)	0.903**	0.250	Valid
	Understanding artificial intelligence	0.913**	0.250	Valid
	Understanding Virtual Classes	0.746**	0.250	Valid
Using offline ICT	Word processing software (e.g. Word, etc.)	0.354*	0.250	Valid
	Number processing software (e.g. Excel, etc.)	0.316*	0.250	Valid
	Presentation software (e.g. PowerPoint, etc.)	0.341*	0.250	Valid
	Graphic design software (e.g. Corel Draw, etc.)	0.850**	0.250	Valid
	Image processing software (e.g. Paint, etc.)	0.809**	0.250	Valid
	Mind map software	0.866**	0.250	Valid
	Using the LCD Projector	0.416**	0.250	Valid
	Able to manage files and folders on the computer	0.632**	0.250	Valid
	Make learning videos (e.g. Camtasia, etc.)	0.666**	0.250	Valid
	Installing the software	0.640**	0.250	Valid
	Uninstall software	0.718**	0.250	Valid
	Solve problems on the Projector LCD display	0.682**	0.250	Valid
Using online ICT	Able to use Local Area Network (LAN) facilities	0.587**	0.250	Valid
	Able to use Hotspot facilities	0.426**	0.250	Valid
	Using e-mail (email)	0.422**	0.250	Valid
	Able to use search engines (e.g. google, opera, etc.)	0.378*	0.250	Valid
	Able to use online learning facilities (e.g. Moodle, Edmodo, etc.)	0.616**	0.250	Valid
	Able to store data online (e.g. google drive, my drive, etc.)	0.633**	0.250	Valid
		0.587**	0.250	Valid
	Able to share data online (e.g. share, etc.)	0.709**	0.250	Valid
	Arrange online learning material	0.695**	0.250	Valid
	Configure online learning videos (YouTube)	0.784**	0.250	Valid
	Using database	0.775**	0.250	Valid
	Use various facilities on a smart phone			

In Table 2 the dominant statement items are in the category of Necessary, there are even 10 statement items that reach 100%. However, 18 statement items are in the sufficiently needed category with an average of 2.91%. Even 6 items in the category are not needed. Furthermore, a table of results of validity and reliability items is presented using moment product correlation analysis.

Based on Table 3, the calculated R value is obtained by using the moment product correlation formula, while the R table value is obtained from table R with a significance level of 0.05 and the

value of the degree of freedom is 60. Based on these results, it can be seen that all statement items are Valid. This is because the R value of the four items is smaller than the R table value of 0.250.

As shown in Table 3. the item statement that measure the extent to which the teacher uses ICT in learning has been validated by involving 63 expert respondents. Table 2 viewed the dominant respondent stated that all items met the category is very necessary. After being tested using product moment correlation, there were 4 items meet the criteria only for 0.05 a significance level, while other items meet the criteria for 0.01 a significance level.

The items which only have 0.05 significance level are the ability of the teacher to use: 1. Word processing software (e.g. Word, etc.), 2. Number processing software (e.g. Excel, etc.), 3) Presentation software (e.g. Power Point, etc.), and 4) The ability of the teacher to use search engines (e.g. google, opera, etc.). These four capabilities are software that have existed since the beginning of the 20th century. This indicates that this ability must have been possessed by a teacher and is no longer an ability that needs to be studied further. [15], [19]–[21].

If seen from the response of experts, all experts give the same value on all four items with a value of 11. These four statement items are the basic things that teachers have to understand decades ago since the computerization era. Teachers' understanding of the use of ICTs is no longer limited to simple use in typing words, numbers, and presentations. Teachers must improve technological literacy skills in the face of the 21st century [5], [7], [13], [14], [16], [20], [22].

This instrument has 3 constructs (understanding ICT, using offline ICT, and using online ICT), the reliability instruments using alpha Cronbach to see the level of reliability of the instrument.

Table 4. Reliability of items statements

Construct	Reliability
Understanding on ICT	0.997
Using offline ICT	0.996
Using online ICT	0.999

From Table 4, the test results show that the statement item above is very reliable to use with value near to 1. This indicated the instruments are ready to distributed to measure teacher ability in using ICT

4. Conclusion

The instrument of the ability of vocational teachers to use ICT in the learning process in Makassar City is divided into 3 aspects, namely a) teacher understanding on ICT, b) using ICT offline, and c) using ICT online. The instrument developed has good characteristics and all of the statement items meet the valid category with a very good level of reliability.

5. References

[1] K. Schuster, L. Plumanns, K. Groß, R. Vossen, A. Richert, and S. Jeschke, “Preparing for Industry 4.0–Testing Collaborative Virtual Learning Environments with Students and Professional Trainers,” *Int. J. Adv. Corp. Learn.*, vol. 8, no. 4, pp. 14–20, 2015.

[2] Z. Zaib and H. Harun, “Leadership in Technical and Vocational Education: Towards Excellence Human Capital,” *Leadership*, vol. 5, no. 23, 2014.

[3] J. E. Aoun, “Robot-Proof: Higher Education in the Age of Artificial Intelligence.,” *MIT Press*, 2018.

[4] K. Ayoub and K. Payne, “Strategy in the age of artificial intelligence,” *J. Strateg. Stud.*, vol. 39, no. 5–6, pp. 793–819, 2016.

[5] A. Durmuş and A. Dağlı, “Integration of vocational schools to industry 4.0 by updating curriculum and programs,” *Int. J. Multidiscip. Stud. Innov. Technol.*, vol. 1, no. 1, pp. 1–3,

2017.
[6] V. Chandra and M. Lloyd, "The methodological nettle: ICT and student achievement," *Br. J. Educ. Technol.*, vol. 39, no. 6, pp. 1087–1098, 2008.
[7] S. R. Arnold, M. J. Padilla, and B. Tunhikorn, "The development of pre-service science teachers' professional knowledge in utilizing ICT to support professional lives," *Eurasia J. Math. Sci. Technol. Educ.*, vol. 5, no. 2, pp. 91–101, 2009.
[8] M. Huda and K. S. M. Teh, "Empowering professional and ethical competence on reflective teaching practice in digital era," in *Mentorship Strategies in Teacher Education*, IGI Global, 2018, pp. 136–152.
[9] S. Lisnawati, "Development of Emotional Quotient Instrument," *J. Eval. Pendidik.*, vol. 2, no. 1, pp. 54–67, 2011.
[10] J. E. Guffey, J. G. Larson, L. Zimmerman, and B. Shook, "The development of a Thurstone scale for identifying desirable police officer traits," *J. Police Crim. Psychol.*, vol. 22, no. 1, pp. 1–9, 2007.
[11] K. Illeris, "Transfer of learning in the learning society: How can the barriers between different learning spaces be surmounted, and how can the gap between learning inside and outside schools be bridged?," *Int. J. Lifelong Educ.*, vol. 28, no. 2, pp. 137–148, 2009.
[12] F. A. Setiawati, "Perbandingan Berbagai Metode Penskalaan Yang Dikembangkan Thurstone," *J. Penelit. Ilmu Pendidik.*, vol. 7, no. 1, 2014.
[13] A.-O. Alazam, A. R. Bakar, R. Hamzah, and S. Asmiran, "Teachers' ICT skills and ICT integration in the classroom: the case of vocational and technical teachers in Malaysia," *Creat. Educ.*, vol. 3, p. 70, 2012.
[14] M. S. Saud, B. Shu, and M. A.-M. Yasin, "Effective integration of information and communication technologies (ICTs) in technical and vocational education and training (TVET) toward knowledge management in the changing world of work," *African J. Bus. Manag.*, vol. 5, no. 16, pp. 6668–6672, 2011.
[15] J. Tondeur, K. Aesaert, B. Pynoo, J. van Braak, N. Fraeyman, and O. Erstad, "Developing a validated instrument to measure preservice teachers' ICT competencies: Meeting the demands of the 21st century," *Br. J. Educ. Technol.*, vol. 48, no. 2, pp. 462–472, 2017.
[16] B. Aberšek and A. Flogie, "Evolution of competences for new era or education 4.0," in *XXV Conference of Czech Educational Research Association (CERA/ČAPV)"Impact of Technologies in the Sphere of Education and Educational Research", Czech*, 2017.
[17] N. A. A. Rahman, S. A. Kadir, M. F. Mohammad, and M. I. A. Moin, "Higher TVET Education in Aviation: Teaching Quality and a Master Key to Industry 4.0," *Int. J. Educ.*, vol. 2, no. 5, pp. 44–53, 2017.
[18] S. Azwar, "Penyusunan Skala Psikologi Cet12," *Yogyakarta: Pustaka Pelalajar*, 2003.
[19] S. Janti, "Analisis validitas dan reliabilitas dengan skala likert terhadap pengembangan si/ti dalam penentuan pengambilan keputusan penerapan strategic planning pada industri garmen," in *Prosiding Seminar Nasional Aplikasi Sains & Teknologi (SNAST)*, 2014, vol. 15, pp. 155–160.
[20] R. Oliver, "The role of ICT in higher education for the 21st century: ICT as a change agent for education," *Retrieved April*, vol. 14, p. 2007, 2002.
[21] E. Van Couvering, "The history of the Internet search engine: Navigational media and the traffic commodity," in *Web search*, Springer, 2008, pp. 177–206.
[22] E. G. Caldarola, G. E. Modoni, and M. Sacco, "A Knowledge-based Approach to Enhance the Workforce Skills and Competences within the Industry 4.0," in *The Tenth International Conference on Information, Process, and Knowledge Management, Rome*, 2018.