A Systematic Literature Review of the 21st Century Skills Scale Development: Preliminary Research Within Education Setting

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Abstract. This study aims to identify the development of the 21st century skills scale that has been carried out by academics/practitioners in various regions. The research questions to be answered are: (1) What is the purpose of scale development? (2) Who are the targets of scale development? (3) What are the aspects used as the basis for developing the 21st century skills scale? (4) What is the scale development procedure? (5) What is the process of data analysis to be able to produce a valid and reliable 21st century skill scale? The research method used is Systematic Literature Review (SLR). The SLR method is used to identify, review, evaluate, and interpret all available research on the topic of the phenomenon of interest, with specific research questions relevant. The research steps are the planning, implementation, and reporting of the research. Research data sources were collected from google scholar (https://scholar.google.com/), science direct (https://www.sciencedirect.com/), ACM digital Library (https://dl.acm.org), Scopus (https://www.scopus.com/). Data analysis using the meta-analysis method. The results showed that: (1) The purpose of developing a scale to measure the level of 21st century skills for respondents. (2) The 21st century skills scale instruments are developed for various levels and fields of education from primary education to higher education. (3) Scale development is generally concluded from the stages: determination of scale items, expert consultation, pretest stage, validity test, reliability test, and finalization of their respective scales. (4) The aspects that each researcher uses are very diverse, in one scale generally using 4-5 aspects. (5) The most widely used instrument analysis/validation process is Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Rasch Model. The study concluded that the 21st century skills scale has been developed according to the needs of each developer. The implication of this research is that academics / education practitioners need to take a role in developing scale. This research can be used as a reference for procedures and analysis of 21st century skills scale development.

Keywords: 21st century skills; scale; SLR

1   Introduction

Globalization, technological developments, international competition, economic changes and environmental and political challenges increase the urgency to develop the skills and knowledge students need to succeed in the 21st century era [1]. In the world of Education, practitioners and experts involved in the field of education have sought to develop the necessary framework for students to be successful in an information and technology-based global society under the concept of 21st century skills [2]. The term 21st century skill is still used today as it is most widely known and used internationally[1][3][3]. The role of teachers or students who will graduate to become educators will face a rapidly changing society through the teaching process in schools and schools must respond to the demands of a changing society. Each teacher will later seek to define how they implement 21st century proficiency in their classrooms [4].

It is necessary to have intensive research efforts in the scope of education to find out the current development of the implementation of education associated with scientific developments as well as technology and information. This is in line with the statement [5] that Educational research has three main objectives. The first is to contribute to the development of the theory, the second is to investigate phenomena that are believed to play an important role in the educational process, and the third is to develop the educational process to be more effective. The purpose of this study focuses on the second goal, which is to identify the phenomenon regarding the implementation of 21st century skills in the world of education.

The important role of 21st century skills to date has not been in line with the instruments used to measure skill level 21 in learners. Development of 21st century skills scale within the scope of education in Indonesia until now has not been widely available This research aims to identify the development of 21st century skill scale instruments from various countries whose results will be used as preliminary research for the next research process.

2   Method

2.1   Research Method

The method used in this study is a systematic literature review. According to [6] Systematic literature review is a means of identifying, evaluating, and interpreting all available research relevant to a particular research question, or topic area, or phenomenon of interest. Literature research is an important thing of academic research. Basically, the advancement of knowledge must be built on pre-implemented research [7].

The Systematic Literature Review aims to evaluate topic research using a trustworthy, rigorous, and accountable methodology. This method is used because the researcher wants to review research articles that researchers have done before [8]. The research literature review can be used to summarize empirical evidence, benefits and limitations, identify gaps in the research that has been carried out to suggest further research, provide a framework/background for constructing new research appropriately

[9][10][10]. Systematic Research is carried out with the aim of identifying the development of the 21st century skill scale, the goals and objectives of scale development, procedures and data analysis processes that have been carried out by researchers to obtain valid and reliable instruments. Data collection techniques use documentation from various journal sources. The research analysis used meta-analysis.

2.2   Procedure and Step

This research procedure follows the opinions [6], [11], [12] namely Planning, Conducting and Reporting. The procedures and stages of this study are presented in Figure 1 below.
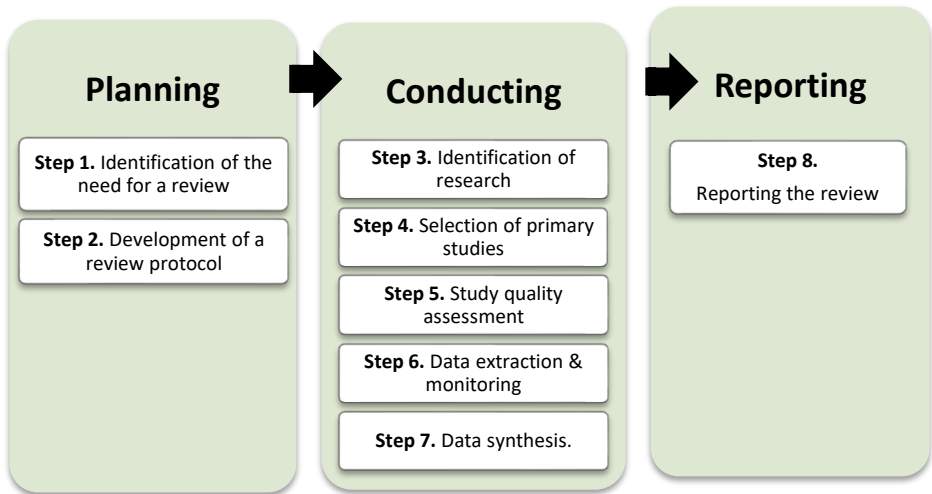
Planning

Step 1. Identification of the need for a review

Step 2. Development of a review protocol

Conducting

Step 3. Identification of research

Step 4. Selection of primary studies

Step 5. Study quality assessment

Step 6. Data extraction & monitoring

Step 7. Data synthesis.

Reporting

Step 8. Reporting the review

Fig. 1. Procedures and Stages of SLR Research

Based on the presentation of Figure 1, the stages carried out in this study can be described, namely:

Step 1. Identification of the need for a review

This stage is carried out by observing the development of needs in the world of education, especially related to the theme of 21st century skills that are needed in the era of the industrial revolution 4.0. The development of a 21st century skills scale to measure the skill level of learners is also still not widely developed. Identification of review needs is also carried out by compiling research questions (RQ). Research questions are determined to keep the review focused on the research objectives. The research questions were designed with the help of Population, Intervention, Comparison, Outcomes, and Context (PICOC) criteria [11] [12][12]. Table 1 shows the structure (PICOC) of the research questions.

Table 1. PICOC Research Questions

Population	Scope of education
Intervention	21st century skills scale
Comparison	Education Level, field of scale development.
Outcomes	The usefulness of the 21st century skills scale
Context	Development of 21st century skills scale for learners, practitioners, academics

Step 2. Development of a review protocol

The literature search process continues at the stage of developing a review protocol, this stage determines the methods that will be used to conduct a systematic review The things that are considered include: research background, research questions, reference sources to be used, criteria for determining library sources, procedures, data check list articles, synthesis and data analysis.

The questions of this study are:

RQ1. What is the purpose of developing the 21st century skills scale by researchers?

RQ2. Who are the goals of 21st century skill scale development by researchers?

RQ3. What are the aspects used as the basis for developing a 21st century skill scale?

RQ4. What is the procedure for developing the skill scale of the 21st century?

RQ5. What is the data analysis process to be able to produce a valid and reliable 21st century skill scale?

Step 3. Identification of research

The purpose of a systematic review is to find as many of the main studies relating to research questions may use unbiased search strategies. Researchers use various combinations of search terms derived from research questions, including: development of the 21st century skill scale, validity and reliability of the 21st century skill scale, 21st century skill instruments, 21st century skills measurement for students. Researchers also traced the library sources used by the study's main literature.

Step 4. Selection of primary studies

Selecting of primary studies consists of several activities: determining the digital sources to be accessed, focusing search keywords, searching for literature that is in accordance with the objectives and research questions. Digital sources used in this study include: google scholar (https://scholar.google.com/), science direct (https://www.sciencedirect.com/), ACM digital Library (https://dl.acm.org/), scopus (https://www.scopus.com/)

The next step is to determine the criteria for inclusion and exclusion. Inclusion criteria are criteria used to determine whether an article fits the topic and research questions under study. Exclusion criteria are criteria used to select parts that do not fit the research question. The criteria used are presented in table 2.

Table 2. Inclusion and Exclusion Criterion

Criterion	Explanation
Inclusion Criteria	Focus on 21st century skills scale development
	The scope of scale development, especially in the field of education
	The procedure and validation of the 21st century skill scale is clear
	Scale development has been carried out in the last 12 years
Exclusion Criteria	The article does not present the purpose and methods of the research clearly
	The skills of the 21stcentury under study are not about scale development but its implementation

Step 5. Study quality assessment

Assessment of the quality of the study (Step 5) can be used to guide the interpretation of the synthesis findings and to determine the conclusions outlined. The purpose of the study quality assessment is to collect evidence from the selected study in order to answer the research questions.

Step 6. Data extraction & monitoring

The selected primary studies were extracted to collect data that contributed to answering this research question. The data is selected based on established criteria and adjusted to the research questions.

Step 7. Data synthesis

Data synthesis involves compiling and summarizing the primary results that the study includes. Synthesis in this study is descriptive / narrative (non-quantitative). The research data is tabulated and sorted according to the research questions.

Step 8. Reporting

The final phase of the systematic review involves writing the results of the review and publishing the results of the study. This aims to be used by interested parties to make this research the basis for further research.

3 Result

The data source of this study consists of 10 articles that discuss the development of the 21st century skills scale within the scope of education. Selected article after passing through several Steps of researching this literature. The identicality of research data sources is presented in table 3.

Table 3. Research Data Sources

No	Authors	Year	Title
	Kamisah Osmana, Tuan Mastura Tuan Sohb, Nu-razidawati Mohamad Ar-sadc *Article 1*	2010	Development and validation of the Malaysian 21st century skills instrument (M-21CSI) for science students [13]
	Nurazidawati Mohamad Arsada *, Kamisah Os-manb , Tuan Mastura Tuan Sohc *Article 2*	2011	Instrument development for21[st] century skills in Biology [14]
	Jo Tondeur, Koen Aesaert, Bram Pynoo, Johan van Braak, Norbert Fraeyman and Ola Erstad *Article 3*	2015	Developing a validated instrument to measure pre-service teachers' ICT competencies: Meeting the demands of the 21st century [15]
	Ş. Dilek Belet Boyacı, Nurhan Atalay *Article 4*	2016	A Scale Development for 21st Century Skills of Primary School Students: A Validity and Reliability Study [16]
	Yueming Jia, Youn Joo Oh, Bernadette Sibuma, Frank LaBanca & Mhora Lorentson *Article 5*	2016	Measuring twenty-first century skills: development and validation of a scale for in-service and pre-service teacher [17]
	Şengül Saime ANAGÜN, Nurhan ATALAY, Zeynep KILIÇ, Serhat YAŞAR *Article 6*	2016	The Development of a21[st] Century Skills and Competences Scale Directed at Teaching Candidates: Validity and Reliability Study [18]
	Toni A. Sondergeld & Carla C. Johnson *Article 7*	2019	Development and validation of a21[st] Century Skills Assessment: Using an iterative multimethod approach [19]
	Alpaslan Sahin, Mirim Kim Myeongsun Yoon *Article 8*	2019	The Development and Validation of a 21st Century Skills Instrument: Measuring Secondary School Students' Skills [20]
	Todd R. Kelley1,* , J. Geoff Knowles2 , Jung Han1 , Euisuk Sung3 *Article 9*	2019	Creating a 21st Century Skills Survey Instrument for High School Students [21]
	Mustafa Cevik, Cihad Senturk, *Article 10*	2019	Multidimensional 21st century skills scale: Validity and reliability study [22]

Data sources are presented to review the suitability of the article to the research question. A number of three articles do not present a clear and straightforward scale-building procedure. There are articles that do not present scale-building goals as well as aspects of21[st] century skills nor are they presented in any of the articles. The data on the results of suitability to quantify the quality of this assessment are presented in table 4 below.

Table 4. Quality Assessment Result

No	Article	RQ1	RQ2	RQ3	RQ4	RQ5
1.	Article 1	√	√	√	√	√
2.	Article 2	√	√	√	√	√
3.	Article 3	√	√	x	√	√
4.	Article 4	√	√	√	√	√
5.	Article 5	√	√	√	x	√
6.	Article 6	√	√	√	√	√
7.	Article 7	√	x	√	√	√
8.	Article 8	√	√	√	x	√
9.	Article 9	√	√	√	x	√
10.	Article 10	√	√	√	√	√

RQ1. The purpose of developing the 21st century skill scale carried out

The purpose of developing a 21st century skill scale is generally used to validate instruments. Instruments that have been tested for validity and reliability will later be used to measure respondents' 21st century skill levels and the follow-up to the use of instruments is to help students to successfully. The purpose of scale development is presented in table 5.

Table 5. The 21st Century Skill Scale Development Goals

No	Title	Scale Development Goals
1.	Article 1	This paper aims to discuss the development and validation process of the Malaysian 21st century skills instrument (M-21CSI) to be used within the teaching and learning of science processes. The development of the Malaysian 21st century skills instrument is as an alternative to identify the necessary skills needed to succeed in the 21st century.
2.	Article 2	This study aims to develop a valid and reliable instrument for measuring 21st century skills towards biology among Malaysian secondary school students
3.	Article 3	The main objective of this study is to develop a self-report instrument to measure preservice teachers' ICT competencies in education.
4.	Article 4	The objective of the present study is to develop a measurement tool to assess 21st Century learning and innovation skills of primary school students
5.	Article 5	A self-report scale that measures teachers' confidence in teaching students about twenty-first century skills was developed and validated with pre-service and in-service teachers
6.	Article 6	The purpose of this study is to put forth the conclusions of a validity and reliability study for a measurement tool which aims to measure the perceptions of teaching candidates directed at 21st century skills.
7.	Article 7	In response to the call for more rigorously validated educational assessments, this study used an iterative multimethod validation

No	Title	Scale Development Goals
		process to develop and validate out-comes from the 21st Century Skills Assessment global rating scale.
8.	Article 8	The goal of this study is to develop and validate an instrument designed to measure secondary school students' self-assessment of 21st century skills they may have developed during K-12 school years.
9.	Article 9	The researchers set out to develop the 21st century skills self-reporting instrument to measure students' assessment of their own abilities
10.	Article 10	This study aims to develop a multidimensional 21st century skills scale for adolescent and early adulthood students in the 15–25 age group.

RQ2. 21st Century Skill Scale Development Goals

The goal of developing the 21st century skills scale has been prepared to share levels, ranging from basic education, secondary education, upper secondary education to higher education. At the tertiary level, there are instruments developed for students as well as pre-service and in-service teachers. The presentation of the goals of 21st century skill scale development is presented in table 6 below.

Table 6. The Goal of Developing the 21st Century Skill Scale

No	Article	Primary School	Secondary School	High School	Pre-service teacher	Undergraduate student
1.	Article 1		√			
2.	Article 2		√			
3.	Article 3				√	
4.	Article 4	√				
5.	Article 5				√	
6.	Article 6				√	
7.	Article 7	-	-	-	-	-
8.	Article 8		√			
9.	Article 9			√		
10.	Article 10			√		√

RQ3. Aspects used as the basis for the development of the 21st century scale

The aspects used as a reference for developing 21st century skill scales vary widely, not limited to Creativity, Communication, Collaboration, Critical Thinking (4C). The basis for using these aspects is also obtained from the sharing of sources. The following are presented what aspects are used by all articles. Presented in the following figure 2.
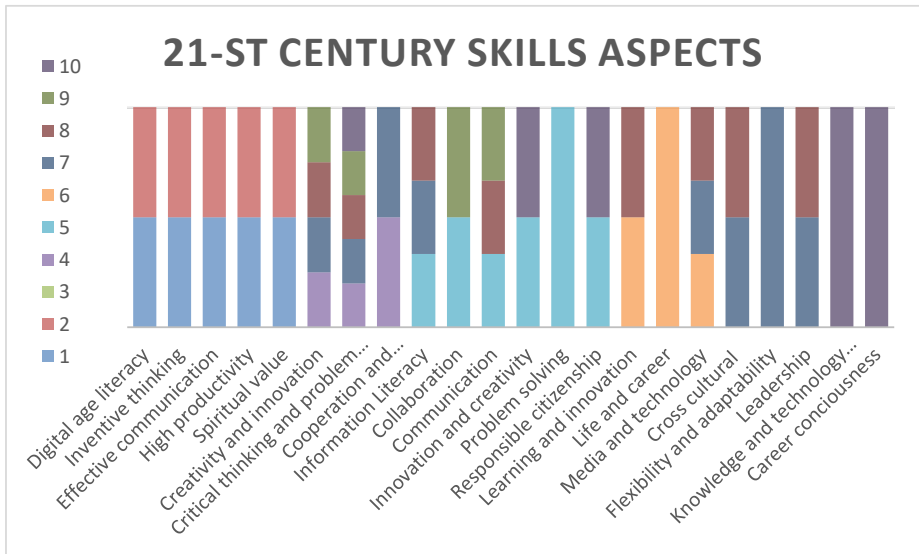
Fig. 2. Aspect for 21st Century Skills Scale

RQ4 & RQ5. Scale development and data analysis procedures to be able to produce a valid and reliable 21st century skills scale

Scale development is generally concluded from the stages: determination of scale items, expert consultation, pretest stage, validity test, reliability test, and finalization of the scale respectively. The most widely used instrument analysis/validation process is Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Rasch Model

Table 7. Scale Development Process and Scale Analysis

No	Title	Scale development process	Scale analysis
	Article 1	Stage 1 began with the identification of salient scales constituting 21st Century Skills; stage 2 involved the writing of individual items within the scales; and finally stage 3 involved the field-testing items followed by an item analysis and validation procedures.	The aim of the factor analysis is to ascertain the fundamental structure of a comparatively large set of variables. Validity use confirmatory factor analysis. The scale reliability using the Cronbach alpha coefficient for a set of questionnaires
	Article 2	The first stage was to identify the suitable components as a research scale.	Using Rasch measurement model, both items and respondents' reliability were

No	Title	Scale development process	Scale analysis
		The second stage was to build the items for each component that has been identified. And finally, the items are constructed to test the validity and reliability by using an appropriate statistical analysis.	able to be analyzed simultaneously. The items and respondents' reliability were measured through data analysis using WINSTEPS 3.69.1.11 application.
	Article 3	The research was set up along distinct phases, involving specific groups of respondents. In a first phase, the analysis of the ICT-CF helped to define questionnaire items. In the next step, 15 stakeholders (ie, preservice teachers, teacher trainers, ICT coordinators and researchers) evaluated the first version of the questionnaire items. This evaluation focused on identifying relevant items to measure the ICT-CF. The final item set was surveyed online with a sample of last-year preservice teachers from TTIs in Flanders in May 2014. The heads of department from 20 TTIs in Flanders (Belgium) were willing to participate in this study	To check the quality of the developed instrument, an exploratory (EFA) and confirmatory factor analyses (CFA) were conducted with two subsamples. A simple random sampling procedure was used to derive both subsamples from the total student sample.
	Article 4	The scale was developed in six stages. These were; (i) establishing the scale items, (ii) consultation of experts, (iii) pretest stage, (iv) determination of structural validity, (v) reliability assessment, and (vi) finalization of the scale respectively	EFA was conducted with the data obtained from the first 304 students, and CFA was conducted using the dataset for the second 305 students in the study.
	Article 5	-	Exploratory factor analyses and confirmatory factor analyses were conducted to examine the scale's validity and reliability.
	Article 6	Considering development process (scanning literature, creating item pool, giving to experts within the area, pre-trial, the determination construct validity) final form of the scale of development.	To determine the validity of the draft scale; the data obtained from 330 of the teaching candidates were used for exploratory factor analysis and 330 were used for confirmatory factor analysis.
	Article 7	The iterative development and validation process is comprised of four phases: (1) Planning, (2) Developing, (3) Qualitative field testing, and (4) Quantitative field testing.	Qualitative and quantitative data sources were used to inform four types of validity evidence: content, response process, internal

No	Title	Scale development process	Scale analysis
			structure, and consequential
	Article 8	-	They utilized exploratory factor analysis and Confirmatory factor analysis (CFA) models for four scales were separately investigated
	Article 9	-	Exploratory factor analysis was appropriate to use for the development of a survey instrument to ensure that it measures the four constructs accurately and investigates the structure of the relationship between variables. Conduct a study using confirmatory factor analysis to validate the instrument.
	Article 10	The first stage of the study, 146 items were selected in line with expert opinions. Within the scope of the validity studies, exploratory factor analysis was carried out. In the second stage of the study, Lisrel 8.80 program was used with confirmatory factor analysis, and the five sub-factor structure was confirmed. In the third stage of the study, the test–retest method was applied	The data obtained from 660 participants were examined in detail before the analysis. The validity and reliability analysis were performed based on the obtained data. The appropriate method for performing the exploratory factor analysis (EFA) and the confirmatory factor analysis (CFA) is to proceed from the data obtained from different sample groups. Lisrel 8.80 program was used with confirmatory factor analysis, and the five sub-factor structure was confirmed.

4   Disicussion

Mastery of 21st century skills is one of the important topics in the development of the industrial revolution 4.0. Nowadays there have been many changes, related to the era of the industrial revolution 4.0, and the demands of life in the 21st century, the demands of these skills are necessary to be able to live in the 21st century[23][24]. The fourth

Industrial Revolution (IR 4.0) has changed the landscape of educational innovation. The revolution in innovation has given birth to the Education model for the future of Education in the 4.0 era [25]. Especially in the field of education measurement, the development of the 21st century skills scale also plays an important role in this decade [26].

More and more business leaders, politicians and educators are united with the idea that students need "skills of the 21st century" to be able to succeed today [27] . The results of the research that has been carried out research shows that in the scope of education, the development of the 21st century skills scale is carried out for various levels of education. The scale was developed for students in elementary schools, middle schools, college students as well as for prospective teachers (students of Education). The skills of prospective teachers are also important to note that it will have an impact on classroom mastery to help learners master the skills needed. The follow-up research conducted by Thieman [28] with preservice teachers in this study shows that when teaching, teachers must be able to determine what and how these educators continue to integrate technology into their teaching and if facilitating their learners to be skilled in the 21st century.

Skills commonly used to introduce the concept of 21st century skills are collaboration, communication, critical thinking, and creativity (4Cs). Nevertheless, there are many aspects presented from various experts to represent the skills of the 21st century. The scale development procedure carried out from each article has met the rules of scale development. Scale development involves many theoretical, methodological and statistical competencies.

Scale development analysis includes using exploratory factor analysis and confirmatory factor analysis. Exploratory factor analysis (EFA) is a statistical technique that is widely used and applied in the Social sciences especially to validate instruments [29]. Factor analysis is used in many areas such as behavior and social sciences, medicine, economics, and geography as a result of advances in computer technology. The two main factor analysis techniques are Exploration Factor Analysis (EFA) and Affirmatory Factor Analysis (CFA). The CFA tries to confirm hypotheses and uses the path of the analysis diagram to represent variables and factors, whereas the EFA tries to uncover complex patterns by exploring data sets and test predictions [30].

5   Conclussion

The study concluded that the 21st century skills scale has been developed according to the needs of each developer. The implication of this research is that academics / education practitioners need to take a role in developing scale. This research can be used as a reference for procedures and analysis of 21st century skill scale development. Researchers can use the results of this study to expand research efforts related to the development of the 21st century skills scale, especially in the scope of education. The development of the 21st century skills scale is also still very rarely found at various levels of education in Indonesia.

Acknowledgement

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