Development of multilevel confirmatory factor analysis of 21st Century Skills Model for Undergraduate Students in Cambodia การพัฒนาองค์ประกอบพหุระดับของทักษะศตวรรษ 21 ของนักศึกษาระดับปริญญาตรีในประเทศราชอาณาจักรกัมพูชา

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Abstract

The purposes of this study was to develop 21st century skills model: (a) to develop a Multilevel Confirmatory Factor Analysis model of 21st century skills for undergraduate students at student and course levels, and (b) to test construct validity of multilevel CFA of 21st century skills of undergraduate students with empirical data. A Five-Likert scale questionnaire was employed for collecting data. The participants were 500 Cambodian undergraduate students in academic year 2018-2019 derived from multistage random sampling.

The multilevel confirmatory factor analysis of 21st century skills for undergraduate student consisted of three mains components 1) Learning and innovation: creativity and innovation skills, critical thinking and problem solving skills, communication and collaboration skills; 2) Information, media and technology literacy skills: Information literacy skills, media literacy skills, and information, communication and technology skills (ICT); 3) Life and career skills: flexibility and adaptability skills, initiative and self-direction skills, social and cross-cultural skills, productivity and accountability skills, and leadership and responsibility skills.

The developed model was consistent with the empirical data considering from χ^2 = 68.316, df = 43, relative chi-square (χ^2/df) = 1.589, $RMSEA$ = .034, CFI = .994, TLI = .984.

The development of 21st century skills for undergraduate student comprised of three main components.

Keywords: 21st century skills, Multilevel confirmatory factor analysis, Learning and innovation skills, Information, media and technology skills, Life and career skills

บทคัดย่อ

การวิจัยครั้งนี้มีวัตถุประสงค์ เพื่อพัฒนาแบบจำลองทักษะในศตวรรษที่ 21 โดย 1) เพื่อพัฒนาโมเดลองค์ประกอบเชิงยืนยันพหุระดับของทักษะศตวรรษที่ 21 ของนักศึกษาระดับปริญญาตรีในระดับนักศึกษาและระดับวิชา และ 2) เพื่อทดสอบความตรงเชิงโครงสร้างองค์ประกอบเชิงยืนยันพหุระดับของทักษะศตวรรษที่ 21 ของนักศึกษาระดับปริญญาตรีกับข้อมูลเชิงประจักษ์ โดยใช้การวิจัยแบบผสานวิธี ขั้นตอนตามลำดับ เครื่องมือที่ใช้ในการเก็บรวบรวมข้อมูลเป็นแบบสอบถาม กลุ่มตัวอย่างเป็นนักศึกษาระดับปริญญาตรีชาวกัมพูชาจำนวน 500 คนปีการศึกษา 2561-2562 ตามการสุ่มแบบหลายขั้นตอน

ผลการวิจัย พบว่า การวิเคราะห์องค์ประกอบเชิงยืนยันพหุระดับของทักษะศตวรรษที่ 21 ของนักศึกษาระดับปริญญาตรีประกอบด้วยองค์ประกอบหลักสามประการคือ 1) การเรียนรู้และนวัตกรรม มีดังนี้ ทักษะความคิดสร้างสรรค์และนวัตกรรม ทักษะการคิดอย่างมีวิจารณญาณ และทักษะการแก้ปัญหา ทักษะการสื่อสารและการทำงานร่วมกัน 2) ทักษะความรู้สารสนเทศ สื่อ และเทคโนโลยี มีดังนี้ ทักษะการรู้สารสนเทศ ทักษะการรู้สื่อ และทักษะการรู้สารสนเทศ การสื่อสาร และเทคโนโลยี 3) ทักษะชีวิตและอาชีพ มีดังนี้ ทักษะความยืดหยุ่นและความสามารถในการปรับตัว ทักษะความคิดริเริ่มและทักษะการกำกับตนเองทักษะทางสังคมและข้ามวัฒนธรรม ทักษะการเพิ่มผลผลิตและความรับผิดชอบ และทักษะความเป็นผู้นำและความรับผิดชอบ

โมเดลที่พัฒนาขึ้นมีความสอดคล้องกับข้อมูลเชิงประจักษ์พิจารณาจาก χ^2 = 68.316, *df* = 43, (χ^2 /*df*) = 1.589, *RMSEA* = .034, *CFI* = .994, *TLI* = .984 ค่าสัมประสิทธิ์การทำนายค่า *R*^{2} ที่ระดับนักเรียนอยู่ระหว่าง. 376 ถึง. 940 และระดับวิชา อยู่ระหว่าง. 268 ถึง .997 3) การพัฒนาทักษะในศตวรรษที่ 21 ของนักศึกษาระดับปริญญาตรีประกอบด้วย 3 องค์ประกอบหลัก

คำสำคัญ: ทักษะศตวรรษที่ 21/ ทักษะการเรียนรู้และนวัตกรรม/ ทักษะสารสนเทศ/ การใช้สื่อ และเทคโนโลยี, ทักษะชีวิตและอาชีพ

Introduction

Skills are major sources of well-being and thriving in the society. They enable activity in a wide array of life areas (Heckman & Corbin, 2016, p. 3). Skills mainly divided into two namely soft skills and hard skills. A survey by Schulz (2008) on the importance of soft skill for students while learning at the university and after university indicate that soft skills are needed for students to obtain full skills beyond their technical academic. Soft skills are very important for learning, social interaction and career advancement (Majid, Liming, Tong, & Raihana, 2012, p. 1036). In the industrial world today, soft skills are needed in order to help the company achieve their goal through employees' contribution.

Employees are the main cells of their organization (Prihatiningsih, 2018). Griffin and Care (2015) propose that 21st century skills are navigation for today education and workplace. 21st century skills are very needed for better students learning quality. With learning and innovation skills, it will help students to master their learning technique. 21st century skills were developed by partnership which divided into three mains parts namely, learning and innovation skills, information, media and technology skills, and life and career skills.

In Cambodia, Technology is lacking at the moment which need to be improved in Cambodia education (PhnomPenhpost, 2018). Richardson, Nash, and Flora (2014) studied on unsystematic technology adoption in Cambodia with 1137students using questionnaires. The result showed that more than 70% of students had less than two years of computer and internet used. Besides, creativity, critical thinking, communication and collaboration skills are crucial for Cambodian students. Those skills will help graduate Cambodian students to survive the competition in the job market (Barrett, 2017). A study by Vong and Wareerat (2016) on critical thinking of trainee students at regional teacher training center in Takeo province, Cambodia aimed to examine and evaluate critical thinking of trainee students found that students' critical thinking ability were at low level. World Bank has pointed out two categories of skills as importance to meet workforce needs in Cambodia. The first is technical skills (i.e., hard skills) that refer to technical abilities specific to a task or activity in the booming sectors (garments, tourist, and construction, but ignoring agriculture). The others are thinking skills and behavior skills including perseverance, self-discipline, teamwork, conflict negotiation, risk management, communication, commitment, decision-making, problem-solving, and self-motivation (WorldBank, 2006, 2010). Based on worldbank (2006 & 2010) some skills of the 21st century skills are still at low level for Cambodian students and not well study yet so Confirmatory factor analysis is the most suitable statistic design uses to find out the level of those skills of undergraduate students in Cambodia.

In Conclusion, students in Cambodia are still low quality of technology skills, thinking skill, teamwork skills, conflict negotiation skills, risk management skills, communication skills, decision-making skills, problem-solving skills self-motivation skills and so on. All of those skills are parts of 21st century skills so conducting a research on 21st century skills assessment criteria should be done now as it is in need for learners, teachers, employees, employers, directors, managers, and leaders. The 21st century skills have not well studied for undergraduate student in Cambodia yet so the study on assessment criteria of 21st century skills for undergraduate students will provide many benefits to curriculum developer, universities, and policy makers as they know the level of undergraduate students' 21st century skills.

Research Objective

1. The development of 21st century skills: a) to develop a Multilevel Confirmatory Factor Analysis model of 21st century skills for undergraduate students at student and course levels; b) to test construct validity of multiple levels CFA of 21st century skills of undergraduate students with empirical data.

Research hypothesis

The 21st century skills framework is consistence with the empirical data.

Research framework

This research is investigating the development of 21st century skills assessment criteria for undergraduate students which following Partnership theory (Partnership, 2008, 2009). 21st century skills divide into three main factors, namely: Learning and Innovation skills, Information skills, Media and Technology skills, and Life and career skills using multilevel method design (Edmonds & Kennedy, 2017, p. 187). In the quantitative research part, the researcher will use multilevel confirmatory analysis (CFA) statistic for analyzing the data; and in the qualitative part, the researcher will use content analysis technique.
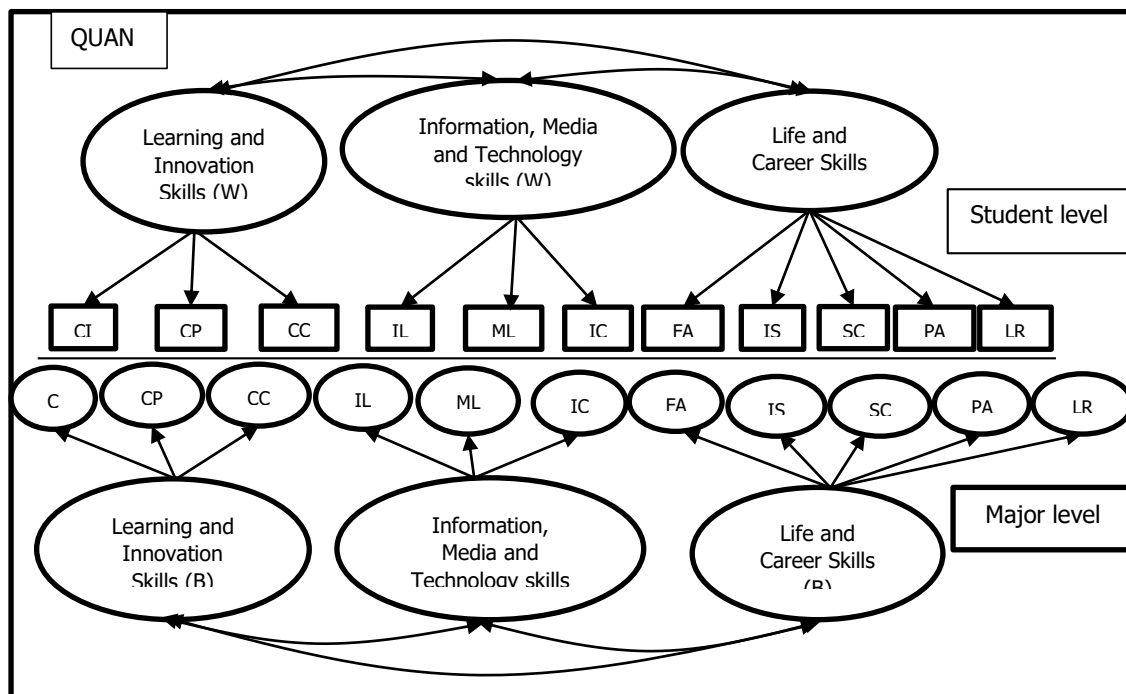

Figure 1: 21st century skills framework

Research Methods

This research was aimed to develop 21st century assessment criteria of undergraduate students in Cambodia, and multilevel confirmatory factor analysis was employed in this

study. In this section, the researchers explained the detail of the development of the measurement tool and the techniques in data analysis.

The population in this research were undergraduate students in Cambodia. There were 63 universities and colleges (119 campuses) with 86 majors (MoEYS, 2016). The researcher randomly selected 50 majors out of 86 majors. To provide equal chances to all participants, the researcher first grouped the same subjects from all the universities than randomly selected one university. The researchers kept doing that for all the majors that were teaching at more than one university. After that, the researcher put together the selected majors with the majors that taught at only one university than randomly selected 50 majors. Ten students were randomly selected from each major. The researcher selected 500 undergraduate students from 50 different majors (Hair, Black, Babin, & Anderson, 2014, p. 100). Most of the participants were females (n=305, 61%), males (n=195,39%). Their ages were from 17 years old to 35 years old, 21 years old (n=114, 22.8%) were the most following by 20 years old (n=108, 21.6%), the least amounts of age were 29, 27 and 35 years old (n=1, 0.2%). The participants were from year I to year IV. Most of the participants were year III (n=199, 39.8%), following by year I (n=116, 23.2%), year II (n=93, 18.6%), and year IV (n=92, 18.4%) respectively.

The 21st century skills framework was adopted from (Partnership, 2008, 2009). The researcher divided the questionnaire into two main parts: (1) participant's general information including Gender, Age, Year of study, and major; (2) questionnaires of 21st century skills using 5 rating scale (Likert scale). The questionnaire was developed based on the operational definition and the total questionnaires were 86 questions which divided into three mains categories namely: (1) learning and innovation skill consisted of 28 indicators, (2) information, media and technology skills consisted of 14 indicators, and (3) life and career skills consisted of 44 indicators. The questionnaire was checked the quality using content validity index (CVI). The content validity of each indicator equaled to 1 which indicated strong content validity (Polit et al., 2007).

After CVI checking, the questionnaire was testing with 30 students to check the reliability. The Cronbach alpha of the questionnaire was excellence which α = 0.99 (George & Mallery, 2016, p. 240; Polit & Beck, 2006; Polit, Beck, & Owen, 2007, p. 466).

The data was collected from undergraduate students in Cambodia. At first, the researcher requests the letter from the college of research methodology and cognitive science for collecting data. Then the researcher brought that letter to Ministry of Education Youth and Spot of Cambodia to get permission for collecting data from undergraduate students. After receiving the permission letter, the researcher brought that letter to all selected universities to collect the data. All the participants were volunteered to participate. All of them filled the consent form before answering to the questionnaire. The consent form was clearly stated that the participants could quite from being a participant

at any time and all the data were used only in education purpose and would keep privately as soft in computer with password.

Results

The finding of the research were as following:

The 21st century skills consists of eleven observes variables which show in the below table.

According to table 1 the data of all the observed variables are normal distribution which mean scores were between 3.60 to 3.99; Standard Division scores were between .51 to .69; Skewness scores were between -.83 to -.50 and Kurtosis scores were between .51 to 1.83 which were in normal curve and it was suitable to for running multilevel confirmatory factor analysis (Kline, 2005, p. 50).

Table 1: The descriptive of the 21st century skills observed Variables

Variables	Mean	SD	Skewness	Kurtosis
Creativity and Innovation skills (CI)	3.73	.51	-0.50	1.17
Critical thinking and Problem solving skills (CP)	3.81	.53	-0.58	1.17
Communication and Collaboration skills (CC)	3.99	.54	-0.82	1.79
Information Literacy skills (IL)	3.60	.66	-0.71	0.96
Media Literacy skills (ML)	3.75	.64	-0.78	1.03
Information, Communication and Technology literacy skills (ICT)	3.87	.69	-0.65	0.51
Flexibility and Adaptability skills (FA)	3.80	.54	-0.78	1.78
Initiative and Self-direction skills (IS)	3.90	.56	-0.63	0.94
Social and Cross-cultural skills (SC)	3.93	.64	-0.68	0.79
Productivity and Accountability skills (PA)	3.80	.56	-0.56	0.89
Leadership and Responsibility skills (LR)	3.92	.54	-0.83	1.83

Confirmatory factor analysis of 21st century skills model for undergraduate students in Cambodia

Table 2: the result of the confirmatory factor analysis of 21st century skills index

Index	Model fit criteria	Scores
Chi-Square (χ^2)	$P > .05$	.005
χ^2/df	< 2.0	1.68
RMSEA	$< .07$	.037
CFI	$> .95$	.991
TLI	$> .95$	.987

According to table 2, the result of multilevel confirmatory factor analysis of 21st century skills for undergraduate students indicate that the model fit well with the empirical data which consider from χ^2 = 65.65, *df* = 39, χ^2/df = 1.68, *RMSEA* = .037, *CFI* = .991, *TLI* = .987. This measurement model has good construct validity that consistence with the empirical data which *CFI* and *TLI* scores are close to 1, *RMSEA* scores greater than .07, χ^2/df scores lower than 2 (Hooper, Coughlan, & Mullen, 2008; Hox, 2002, pp. 238-240)

The factor loading of confirmatory factor (β) of 21st century skills at positively significant at level .01. The coefficient prediction value (R^2) were between .487 to .738 which meant the indicators could explain the variance of all indicators in between 48.7% to 73.8%.

Table 3: the result of the multilevel confirmatory factor analysis of 21st century skills index

Index	Model fit criteria	Scores
Chi-Square (χ^2)	*P* > .05	.008
χ^2/df	< 2.0	1.589
RMSEA	< .07	.024
CFI	> .95	.994
TLI	> .95	.984

According to table 3, the result of multilevel confirmatory factor analysis of 21st century skills for undergraduate students indicate that the model fit well with the empirical data which consider from χ^2 = 68.316, *df* = 43, χ^2 /df = 1.589, *RMSEA* = .034, *CFI* = .994, *TLI* = .984. This measurement model has good construct validity that consistence with the empirical data which *CFI* and *TLI* scores are close to 1, *RMSEA* scores greater than .07, χ^2 /df scores lower than 2 (Hooper, Coughlan, & Mullen, 2008; Hox, 2002, pp. 238-240).

Due to the validity of the multi-level confirmatory factor analysis model (MCFA), the studied variables have to be at both levels. Therefore, it was appropriate to analyze the model of multi-level CFA which considering on intraclass correlation coefficient (ICC). The ICC ranges in value from 0 to 1, with higher values of the ICC indicating greater proportions of between-level variance. In table 2, ICC values were range from .089 to .191. The observed variables were ordered from the highest ICC value to the lowest as following: CI, PA, CP, IS, FA, ICT, CC, LR, ML, SC, and IL which ICC values equal to .191, .156, .155, .141, .129, .128, .127, .126, .114, .106, and .089 respectively indicated significantly difference between student level and major level (Dyer, Hanges, & Hall, 2005, p. 155).

The factor loading of multilevel confirmatory factor (β) of 21st century skills at student level positively significant at level .01. The factor loading value were between .613 to .969. The coefficient prediction value (R^2) at student level of all indicators were between .376 to .940 which meant the indicators could explain the variance of all indicators in between 37.6% to 96%. At Major level, all the observed variable had factor loading (β) positively significant at level .01. The factor loading values were between .518 to .998. the coefficient prediction value (R^2) were between .268 to .997 which meant the indicators could explain the variance of all indicators in between 26.8% to 99.7%.

In conclusion, the multilevel confirmatory factor analysis of 21st century skills for undergraduate student consistence with the empirical data.

Multilevel confirmatory factor analysis of 21st century skills for undergraduate student at both student level and major level consisted of 11 observed variables namely Creativity and Innovation skills (CI), Critical thinking and Problem solving skills (CP), Communication and Collaboration skills (CC), Information Literacy skills, Media literacy skills (IL), Information, Communication, and Technology Literacy skills (ICT), Flexibility and Adaptability skills (FA), Initiative and Self-direction skills (IS), Productivity and Accountability skills (PA), and Leadership and Responsibility skills (LR).

Conclusion and discussion

The 21st century skills measurement for undergraduate student consisted of three mains latent variables such as 1) Learning and innovation skill which consisted of creativity and innovation skills (9 indicators), critical thinking and problem solving skills (9 indicators), communication and collaboration skills (10 indicators); 2) information, media and technology literacy skills consisted of information literacy skills (5 indicators), media literacy skills (5 indicators), ICT literacy skills (5 indicators); and 3) Life and career skills consisted of flexibility and adaptability skills (10 indicators), initiative and self-direction skills (10 indicators), social and cross-cultural skills (5 indicator), productivity and accountability skills (10 indicators), and leadership and responsibility (10 indicators). All the measurement indicators were consistence with the empirical data which could be used to measure 21st century skills of undergraduate students in Cambodia. The finding is consistence with the framework of Germaine, Richards, Koeller, and Schubert-Irastorza (2016); Partnership (2009) and Trilling and Fadel (2009) 21st century skills is an overarching description of the knowledge, skills, and dispositions seen as prerequisites for success in the global workplace of the future. 21st century skills are the combination of soft skill and technology. Soft skills are needed to success in everyday life. Technology is the important addition source. With technology bring the world to become a small village. Everyone can see or find all most everything on earth on internet.

All in all, 21st century skills are needed for everyone in this generation to live a happy life. Today learning and working environment need all these skills to keep up to date on information of learning, news, works, health, or traveling. These skills will help every individual to walk faster comparing to those who lack of them.

The suggestion for using the finding of the research

The study found that at student level communication and collaboration skills, media literacy skills, flexibility and adaptability skills had the highest factor loading and for major level flexibility and adaptability skills, media literacy skills, and critical thinking and problem solving skills had the highest factor loading so the university in Cambodia should support these skills as priority.

The university committees should use this finding as a base line to effectively develop 21st century skills for undergraduate student.

Before using this 21st century skills assessment, user should study well on the method from this study so users will accurately assess 21st century skill for undergraduate student.

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