ORIGINAL ARTICLE

The 21st-century skills among public health undergraduate students in autonomous universities in Thailand after the COVID-19 pandemic

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ABSTRACT

Adopting new skills is essential for success in the 21st century, especially in education and public health. As career transitions and lifelong learning increase, educational institutions are adapting their approaches. They are integrating technology and resources to help students apply knowledge effectively. This cross-sectional study employed stratified-cluster random sampling approach to assess 21st-century skills and six related factors—academic year, esteem for oneself, esteem for others, active learning, qualities of effective teachers, and learning environment—among 537 second- to fourth-year undergraduate public health students from four autonomous universities in Thailand. Data were collected using self-administered questionnaires between January and March 2023. The reliability coefficients of the scales ranged from 0.78 to 0.93. Data were analyzed using descriptive statistics, one-way ANOVA, Pearson's product-moment correlation, and stepwise multiple linear regression, with the significance level set at less than 0.05.

Research findings indicated that 60.5% of students had high levels of 21st-century skills, while 39.5% had moderate levels. Fourth-year students scored higher on these skills compared to those in the second and third years. Five factors, including two subscales of self-esteem and three dimensions of teaching and learning management during the COVID-19 pandemic, were identified as predictors of 21st-century skills, accounting for 54.2% of the variance.

To provide early-year students with the necessary skills and opportunities for lifelong learning, curriculum administrators should promote activities that enhance 21st-century skills, boost self-esteem, and provide adequate support for learners, instructors, and learning environments.

Keywords:
21st-century skills; teaching and learning management; public health education; self-esteem; lifelong learning

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INTRODUCTION

To keep up with the world's changes, one must adapt. The essential knowledge and abilities required for success in work and life in the 21st-century have been defined by the Partnership for 21st-century Skills (P21).[1] These abilities fall into four categories: 1) Core subjects, such as reading, writing, and arithmetic; 2) Learning and innovation skills; 3) Information and Communication technology (ICT) skills; and 4) Life and career skills. Developing 21st-century skills is crucial for inclusive, equitable, high-quality education and opportunities for lifelong learning. Equipping young people with these fundamental abilities is vital if society is to meet its future needs. The quality of the educational system and the competencies of graduates are key determinants of skilled human resources, which are critical components of competitive capability.

The new generation frequently switches careers across various fields, which makes transferring their skills to new settings challenging. Additionally, students need to acquire crucial 21st-century skills. Educational institutions are altering their teaching methods, incorporating technology, and making learning accessible at any time. Teachers must adapt by becoming coaches, co-investigators, and facilitators, enabling students to access diverse learning resources. With the support of learning skills in teaching and assessment processes, students should be able to transform knowledge into wisdom. Integrating education in the 21st century necessitates offering students opportunities to develop and sustain interests through a range of curricular and extracurricular activities.[2-3]

The World Bank recently released data from a survey of the skills and preparedness of the population aged 15-64 in Thailand. The survey revealed that 18.7% of individuals have low basic skills including foundational reading literacy, digital, and socioemotional skills. This represents a skills crisis among Thais, as these basic skills are essential for working and living in the 21st-century.[4] Conventional education methods are insufficient for fully developing the necessary 21st-century skills. To develop these future skills, Education 4.0 focuses on key areas: the abilities students need, the technology used for learning, and the quality of the educational infrastructure.[3] Previous studies found that during the academic years,[5-6] active learning, qualities of effective teachers, and the learning environment[5-8] have all been identified as factors related to 21st-century skills among undergraduate students. Self-esteem is crucial in promoting adolescents' potential, influencing their behaviors and self-perception,[9] and playing an integral role in shaping dental students' perceptions of their professional abilities.[10]

Thai universities promote 21st-century skills through various activities. However, the COVID-19 pandemic disrupted conventional teaching methods, requiring a reassessment of their effectiveness in developing these skills. This disruption is particularly critical for public health students who need simulated and real-world practice. The shift to online learning during the pandemic impeded continuous skill development. Nonetheless, monitoring the growth of 21st-century skills across different academic levels remains crucial for producing graduates with the desired attributes.

This study examines 21st-century skills and related factors among public health undergraduate students in autonomous universities in Thailand. It is based on the 21st-century skills framework defined by P21.[1] The study focuses on three dimensions: 1) Learning and innovation skills, 2) Information, media, and technology skills, and 3) Life and career skills. Core subject skills were excluded

because they are generally considered foundational knowledge that does not require additional emphasis in this context. The related factors are classified into: 1) Personal factors, such as academic year and self-esteem, and 2) Teaching and learning management during the COVID-19 pandemic, which includes three components: active learning, qualities of effective teachers, and the learning environment. This information helps educational institutions design learning processes that prepare students to become effective and competent citizens in the 21st-century.

METHODS

Study Design

This study employed a cross-sectional survey design, utilizing a self-administered questionnaire conducted from January to March 2023.

Participants

Undergraduate students enrolled in the Bachelor of Public Health program at autonomous universities in Thailand were required to meet the following criteria: (1) enrolled in the 2nd to 4th year during the 2022 academic year, (2) having at least one year of learning experience during the COVID-19 pandemic, and (3) being in good health. Additionally, participants were required to provide informed consent to participate in the study. A suitable sample size was calculated using the formula for estimating population means for an infinite population in a multi-center study.[11] Based on a mean of 78.4, a standard deviation of 8.58 (derived from the pilot study), an acceptable margin of error of 1.2, and a design effect of 2.0, a total of 394 subjects were required. To account for potential non-responses, the sample size was increased by 40%, resulting in a total of 552 participants.

Sampling procedure

A stratified-cluster random sampling method was employed. Stage 1: twelve autonomous Thai universities that offer a Bachelor of Public Health program and are accredited by the Community Public Health Council were classified into four groups based on their regions.[12-13] Stage 2: one university was randomly selected from each of the four regions using simple random sampling, resulting in a total of four representative universities. Stage 3: all second- and fourth-year students from these universities who met the inclusion criteria and provided informed consent were recruited. Participants who withdrew from the study or did not complete the questionnaire were excluded.

Research Instruments

A self-administered questionnaire was developed by researchers based on a thorough literature review and the P21 framework. The questionnaire was then validated by a panel of three experts specializing in teaching, public health, and measurement, achieving a content validity index of 0.7-1. The questionnaire was piloted with 30 undergraduate students to evaluate face validity, item discrimination, and reliability.

The questionnaire consisted of four parts: Part 1 addressed participants' general information, including academic year, sex, GPA, and experience with 21st-century skill training. Part 2 focused on teaching and learning management during the COVID-19 pandemic. It comprised fifteen items across three dimensions based on a literature review:[5-8] (1) Active Learning assessed learner engagement through exploration, collaboration, immediate application of knowledge, and problem-solving; (2) Qualities of Effective Teachers evaluated attributes such as meeting students' needs, embracing new ideas, staying positive, having specialized

knowledge, and using precise, engaging methods; and (3) Learning Environment examined the effectiveness of lesson plans, the learning environment, materials, equipment, and overall atmosphere. This included their relevance for online and in-person classes, and their ability to build technical and personal skills. Each dimension consisted of 5 items rated on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Cronbach's alpha coefficients for the dimensions ranged from 0.78 to 0.86. Part 3 assessed self-esteem using Coopersmith's concept of self-esteem,[9] consisting of 10 items divided into two subscales: (1) esteem for oneself (5 items) and (2) esteem for others (5 items). The responses were rated on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), with a higher score referring to a higher level of self-esteem. Cronbach's alpha coefficients ranged from 0.84 to 0.90. Part 4 assessed 21st-century skills based on the Partnership for 21st-century Skills framework, which includes three dimensions.[1] This section comprised 21 items across the following dimensions: (1) learning and innovation skills (9 items); (2) information, media, and technology skills (5 items); and (3) life and career skills (7 items). Participants rated their responses on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Cronbach's alpha coefficients ranged from 0.85 to 0.93. The overall percentage score for 21st-century skills was categorized into three levels: <60% (Low), 60%-79% (Moderate), and >80% (High) according to Bloom's criteria.[14]

Data Collection

The researcher requested permission to collect data from the directors of Bachelor of Public Health programs at all four universities, including the ethics committee certificate. After obtaining permission, the research team introduced themselves and explained the research objectives and the data collection process. The research team distributed the self-administered questionnaires during class, which took about 10-15 minutes to complete. They kept the completed questionnaires separate from the consent forms to ensure anonymity. Of the 552 questionnaires returned, 537 were complete, resulting in a completion rate of 97.28%.

Data Analysis

SPSS software, version 18.0, under the Mahidol University license, was utilized to conduct descriptive statistics, one-way ANOVA with Scheffé's post-hoc test, Pearson's product-moment correlation, and stepwise multiple linear regression analysis. Statistical significance was set at less than 0.05.

RESULTS

The majority of participants were female (89.6%). Regarding academic year distribution, 36.7% were third-year students, 33.5% second-year, and 29.8% fourth-year students. About 37.4% had a GPA ranging from 3.01 to 3.5. Of the participants, 75.0% reported no experience with 21st-century skills training activities during the COVID-19 pandemic, while 25% had some exposure. The most common experiences included collaboration, teamwork, and leadership skills (62.2%), communication, information, and media literacy (61.5%), and critical thinking and problem-solving skills (45.2%) (Table 1).

Table 1. Demographic data of public health undergraduate students (n=537).

Personal information	Number	Percentage
Gender		
Female	481	89.6
Male	56	10.4
Current academic year		
2nd	180	33.5
3rd	197	36.7
4th	160	29.8
GPA		
1.00 – 2.00	2	0.4
2.01 – 2.50	54	10.0
2.51 – 3.00	183	34.1
3.01 – 3.50	201	37.4
3.51 – 4.00	52	9.7
No Response	45	8.4
Experience in 21st-century skills training activities		
None-experienced	402	74.9
Experienced	135	25.1
List of 21st-century skills training activities (Multiple responses allowed) (n = 135)		
1) Learning and innovation skills		
-Critical thinking and problem-solving skills	61	45.2
-Creativity and innovation skills	34	25.2
2) Information, media, and technology skills		
-Communication, information, and media literacy	83	61.5
-Computer, information, and communication technology literacy	58	43.0
3) Life and career skills		
-Cross cultural Understanding skills	27	20.0
-Collaboration, teamwork, and leadership skills	84	62.2
-Career, learning, and compassion skills	34	25.2

Perception of 21st-century skills

The study revealed that approximately 60% of students rated their 21st-century skills as high, while about 40% assessed them as moderate. Examination of the three skill categories showed that most undergraduates rated their skills as high: 68% for Life and Career skills (LC), 59% for Information, Media, and Technology skills (IMT), and 52% for Learning and Innovation skills (LI) (Table 2).

Table 2. The 21st-century skills among public health undergraduate students.

Variables	Range	Mean ± SD.	Level		
			Low	Moderate	High
Overall 21st-century skills	53 – 104	80.95 ± 9.78	0.0	39.5	60.5
-Learning and innovation skills	23 – 45	34.24 ± 4.38	0.0	47.7	52.3
-Information, media, & technology skills	10 – 25	19.10 ± 2.94	0.4	40.6	59.0
-Life and career skills	18 – 35	27.62 ± 3.67	0.0	32.0	68.0

Comparison of overall 21st-century skills by academic year

Fourth-year students demonstrated the highest average overall scores in 21st-century skills, followed by third-year and second-year students, including subscale scores for LI, IMT, and LC. Post hoc analysis revealed a significant difference in average scores for 21st-century skills and LI, with Year 4 students scoring higher than Year 3 and Year 2 students. Additionally, Year 4 students had significantly higher average scores in IMT and LC than Year 2 students. There was no significant difference between Year 3 and Year 2 students (Table 3).

Table 3. Comparison of average scores of 21st century skills by academic year.

Academic Year	n	21st-century Skills; Mean ± SD			
		LI	IMT	LC	Overall
2nd	180	33.59 ± 3.52	18.79 ± 2.65	27.22 ± 3.33	79.61 ± 8.14
3rd	197	33.73 ± 4.35	18.98 ± 2.78	27.48 ± 3.98	80.19 ± 9.87
4th	160	35.58 ± 4.97	19.59 ± 3.37	28.24 ± 3.59	83.41 ± 10.92
F-value		11.216***	3.387*	3.512*	7.508**
Post-hoc comparisons		4th > 2nd*** 4th > 3rd***	4th > 2nd*	4th > 2nd*	4th > 2nd** 4th > 3rd**

*p-value < 0.05, **p-value < 0.01, ***p-value < 0.001

Note: LI = Learning and innovation skills, IMT = Information, media and technology skills, LC = Life and career skills

Factors related to 21st-century skills in Public Health undergrads

The findings showed that six variables were significantly correlated with 21st-century skills: esteem of oneself, active learning, qualities of effective teachers, learning environment, esteem for others, and academic year, with correlation coefficients ranging from 0.152 to 0.649 (Table 4).

Table 4. Inter-correlation values of variables.

Variables	Pearson's Product Moment Correlation (r)					
	1	2	3	4	5	6
1. Academic year	1					
2. Esteem for oneself	0.148**	1				
3. Esteem for others	-0.033	0.511***	1			
4. Active learning	0.221***	0.495***	0.342***	1		
5. Qualities of effective teachers	0.127**	0.465***	0.332***	0.618***	1	
6. Learning environment	0.089*	0.526***	0.378***	0.589***	0.752***	1
Overall 21st-century skills	0.152***	0.649***	0.451***	0.567***	0.552***	0.572***

*p-value < 0.05, **p-value < 0.01, ***p-value < 0.001

Multiple linear regression analysis identified five key variables predicting 21st-century skills among Public Health undergraduates: 1) esteem for oneself, 2) active learning, 3) qualities of effective teachers, 4) learning environment, and 5) esteem for others. These variables together accounted for 54.2% of the variance in 21st-century skills among the students. Among these, esteem for oneself was the most significant predictor (Table 5).

Table 5. Factors predicting overall 21st-century skills

Predictive Variables	B	Beta	t-value	p-value	Tolerance	VIF
Esteem of oneself	1.335	0.375	9.69	< 0.001	0.577	1.733
Active learning	0.691	0.192	4.83	< 0.001	0.546	1.830
Qualities of effective teachers	0.429	0.133	2.81	< 0.01	0.387	2.584
Learning environment	0.430	0.123	2.58	< 0.05	0.381	2.622
Esteem for others	0.378	0.103	2.98	< 0.01	0.719	1.390
Constant	17.561	-	6.29	< 0.001	-	-

$R^2 = 0.542$, Adjusted $R^2 = 0.538$, Durbin-Watson = 1.818

DISCUSSION

This study explored the perception of 21st-century skills among undergraduate public health students at autonomous universities in Thailand, focusing on those in their second to fourth-year academic studies. Most participants were female and had previously engaged in 21st-century skills training during the COVID-19 pandemic. More than half of the students perceived themselves as having high levels of these skills, consistent with similar studies at the undergraduate level.[5-8] All three dimensions of 21st-century skills were rated highly, with LC skills standing out at 68%, likely due to extensive participation in LC training activities. One study found that individuals can acquire knowledge through observation and personal experience,[15] which may explain the high ratings in LC skills.

However, while students have easy access to the internet, some have a low level of IMT literacy, leading to challenges such as internet addiction and poor emotional intelligence.[16] Health science students demonstrated higher levels of 21st-century skills compared to their peers in other disciplines,[6-7] emphasizing the critical role of educational institutions.

Unfortunately, the COVID-19 pandemic disrupted skill-building activities, contributing to inconsistencies in skill development and declines in perceived proficiency. Perception scores were highest among fourth-year students, followed by third-year and second-year students. This trend highlights the progressive nature of the Bachelor of Public Health curriculum, which transitions from foundational courses in the early years to more complex, professional coursework in later years. Advanced courses and practical applications in the third and fourth years likely enhanced students' ability to think critically and creatively, promoting flexibility and the synthesis of new ideas.[6,17,18] Nevertheless, no significant difference was observed between second- and third-year students. This may be due to both groups adjusting to new academic challenges, limiting their engagement in skill-building activities.[18] Transitioning into these years often brings increased academic and social pressures, which can impact students' participation in experiential learning and development opportunities.[19]

The study also identified key factors influencing the development of 21st-century skills, with self-esteem emerging as a critical component. High self-esteem motivates students to actively engage in critical thinking and creativity.[9] It also fosters a cooperative environment, promoting teamwork and effective communication, both key components of these skills.[20] Regular practice enhances accuracy, proficiency, and confidence, reinforcing skill development over time.[10,21-22] Adolescence, as a period of exploration and self-discovery, plays a significant role in shaping self-worth and

confidence.[23-24] Supporting self-esteem during this stage equips students to handle challenges and appreciate diversity in others, promoting positive collaboration.[25] Additionally, students with high self-esteem are more likely to set ambitious goals, actively participate in education, and achieve better academic performance.[26-27] Creating a supportive environment further enhances self-esteem, fostering positive social interactions and peer collaboration.[28]

Educational institutions play a pivotal role in developing 21st-century skills. Effective learning design, which includes prepared learners, skilled instructors, and supportive environments, is essential.[1] A combination of student-related factors, teaching processes, and institutional support strongly predicts 21st-century skill development.[3,5] Teachers must shift their roles to act as supporters and guides, encouraging students to learn independently through hands-on experiences. This approach has been shown to be effective in fostering 21st-century skills.[1,7] Stimuli or environmental factors that support the learning process also enhance student engagement and learning potential.[25,29] Furthermore, regular practice through trial and error is essential for skill acquisition, with cognitive and environmental factors playing a critical role in shaping learning behavior.[15,32]

The COVID-19 pandemic disrupted skill-building activities, contributing to inconsistencies in skill development and declines in perceived proficiency. Universities should address these gaps by targeting IMT literacy and emotional intelligence, which are essential for modern learning environments. Incorporating practical applications, especially in advanced coursework, is necessary to strengthen students' proficiency. Experiential learning and collaborative projects are particularly effective in boosting critical thinking, teamwork, and self-confidence—key aspects of 21st-century skills. Integrating these skills throughout the curriculum, with increasing complexity from the 2nd to 4th year, is critical to enhancing student outcomes. Universities must prioritize practical, hands-on learning opportunities and provide targeted support to address challenges such as low IMT literacy and emotional intelligence. Consistent effort and reinforcement through practice remain essential for developing proficiency in 21st-century skills.

LIMITATIONS

Self-reported data may introduce response bias, leading to over reporting due to social desirability. To improve the accuracy and reliability of future studies, incorporating qualitative methods would provide a more comprehensive understanding of the findings. As a cross-sectional study collects data at a specific time, it cannot establish cause and effect relationships. Additionally, recall bias may affect the accuracy of individuals' recollections, particularly in evaluations of teaching and learning during the COVID-19 pandemic. While self-esteem and 21st-century skills were reported, addressing these biases is important for obtaining more reliable results. A prospective cohort study that tracks behaviors over time is recommended to address this limitation.

CONCLUSIONS AND RECOMMENDATIONS

The results of this study indicated that six out of ten undergraduate public health students had a high level of 21st-century skills. Fourth-year students demonstrated higher skill levels than those in their second and third years. Curriculum enhancement, specifically fostering self-esteem, is needed to promote the continuous development of 21st-century skills across all academic years. The study identified five factors that could predict

21st-century skills, accounting for 54.2% of the variance. Future research could explore additional related factors, such as digital literacy, to better understand their impact on developing 21st-century skills.

AUTHOR CONTRIBUTIONS

S.P., W.K: Conceptualization. S.P.: Data curation. S.P., W.K.: Methodology. S.P., K.Z.: Formal analysis. W.K.: Validation/Supervision. S.P.: Project administration. SP.: Funding acquisition. K.Z.: Writing–original draft. S.P., K.Z., W.K.: Writing–review & editing.

ETHICAL CONSIDERATION

The protocol for this study was reviewed and approved by the Human Research Ethics Committee of the Institute for Population and Social Research, Mahidol University (COA. No. 2022/09-187) on September 29, 2022 and January 3, 2023. Participants were informed of their rights, including participation, withdrawal, and confidentiality, and provided written consent.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

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