

Effects of the 4C Core Competencies on Work Ability among Dental Hygienists

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Background: This descriptive study aimed to examine the relationship between the 4C core competencies and work ability among dental hygienists.

Methods: From November 2018 to January 2019, data were collected from 190 dental hygienists working in dental clinics in Busan, Ulsan, and Gyeongsangnam province using structured questionnaires. For the general characteristics of the dental hygienists, frequency and percentage were calculated, and the level of the 4C core competencies and work ability of dental hygienists was calculated using means and standard deviations. A multiple regression analysis was conducted to analyze the effects of the 4C core competencies on work ability.

Results: The mean scores for the 4C core competency levels of the dental hygienists were as follows: communication ability 3.34, critical thinking ability 3.41, creative problem-solving 3.40, and collaborative self-efficacy 3.27. Meanwhile the mean score for work ability level was 3.65. The predictive factors influencing work ability were communication ability and cooperative self-efficacy ($p < 0.001$), and the sub-factors of critical thinking ability that affect work ability were sound conferences ($p < 0.01$), intellectual fairness ($p < 0.05$), intellectual enthusiasm ($p < 0.05$), and self-confidence ($p < 0.001$). Finally, the sub-factors of creative problem-solving ability that affect work ability were planning and execution ($p < 0.01$) and performance evaluation ($p < 0.05$).

Conclusion: The current study showed that education programs covering the core competencies of dental hygienists, rather than the existing theoretical education program, should be developed and implemented to enhance 4C core competencies that affect work ability.

Key Words: Ability, Communication, Critical thinking, Problem solving, Self-efficacy

Introduction

In recent years, as the education level of patients has increased and information acquisition has become easier¹⁾, knowledge and awareness of medical care have increased and awareness of patients' rights and rights to self-determination has been strengthened²⁾. Furthermore, as patient participation has increased, communication with patients has expected to become increasingly important, and preparation is required to develop work ability to actively accept and respond to the changing environment of dental clinical treatment caused by the Fourth Industrial Revolution.

Work ability refers to the ability to perform work proficiently using appropriate knowledge, decisions, and clinically required skills³⁾, and as the social demand for dental hygienists has changed, the scope of their work ability has expanded from cooperative work using simple knowledge and skills to prevention, education, interpersonal skills, and serving as a business thus⁴⁾. Core competencies that suit the current trend are required to develop work abilities in preparation for the future society. Among the numerous competencies, communication ability, critical thinking ability, creative problem-solving ability, and collaborative self-efficacy have been considered the 4C core competencies required for the Fourth Industrial

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Revolution⁵⁾.

Communication is a complex action of delivering one's own message and receiving another's to mutually exchange one's thoughts and feelings with one's interlocutor⁶⁾, and the communication ability of dental hygienist affects organizational effectiveness⁷⁾.

Critical thinking refers to making the best decision by understanding the logical structure and meaning of information and considering evidence and methods in determining whether to accept a certain opinion and to take a certain action⁸⁾. A significant positive correlation was observed between critical thinking ability and problem-solving ability as well as job performance among dental hygienists⁹⁾, and when critical thinking propensity is high in the nursing domain, a decision can be made quickly and efficiently in a high-risk situation relevant to clinical competence and patient safety¹⁰⁾.

Creative problem-solving refers to a creative and intelligent ability to recognize the difference between one's current state and goals and to address this gap¹¹⁾. When a difficult situation related to the safety of patients is encountered, problem-solving ability is required to quickly identify and solve problems¹⁰⁾.

Collaborative self-efficacy refers to the belief of an individual learner that he/she can perform a team project successfully and contribute to a collaborative activity¹²⁾. As self-efficacy increases, one sets high work-related goals and endeavors proactively to achieve self-efficacy, thereby affecting organizational commitment¹³⁾.

A previous study has found that communication, critical thinking, creative problem-solving, and collaborative self-efficacy are significant for dental hygienists, However, no study has assessed the effects of the 4C core competencies on work ability.

Therefore, this study aimed to investigate the effects of the 4C core competencies on work ability among dental hygienists. Furthermore, we assessed whether problem-solving-oriented participatory educational programs based on the 4C core competencies rather than the conventional theoretical education, should be developed developed to enhance the work abilities of dental hygienists which is required in the Fourth Industrial Revolution.

Materials and Methods

1. Study participants

The study was conducted from November 2018 to January 2019. Of the 200 copies of the survey questionnaire that were distributed, 190 with honest responses were honestly answered were collected and analyzed. The study participants were dental hygienists working in dental clinics and general hospitals located in Gyeongsangnam province, Ulsan, and Busan, and a structured survey targeting 200 respondents was conducted after the objectives of the study were explained and consent was obtained. Using G*power 3.1.3 based on Cohen's power analysis, a minimum sample size of 181 was required under the following conditions: 5% (both sides) significance level, 80% power, and 0.15 effect size. However, considering the possible drop-out rate, the survey included a total sample size of 200.

2. Study methods

1) Communication ability

A tool developed by Lee¹⁴⁾ was used to measure the variables of communication ability. A total of 49 questions was developed for the following sub-factors: used. A total of 49 questions were developed under five sub-factors: solving ability, role-performing ability, self-presentation ability, goal setting ability, and message transition ability. Each question was scored on a 5-point Likert scale, and a high score indicated that the participants had a high level of communication ability. For communication ability, the Cronbach's alpha value was 0.84.

2) Critical thinking ability

A tool developed by Yoon¹⁵⁾ was used to measure the variables of critical thinking ability. A total of 27 questions was developed for the following sub-factors: healthy skepticism, intellectual fairness, objectivity, systematicity, prudence, intellectual passion, and self-confidence. Each question was scored on a 5-point Likert scale, and a high score indicated that the participants had a high level of critical thinking ability. For critical thinking ability, the Cronbach's alpha value was 0.91.

3) Creative problem-solving ability

A tool developed by Lee¹⁴⁾ was used to measure the variables of creative problem-solving ability. A total of 45 questions was developed for the following sub-factors: problem clarification, causal analysis, development of alternatives, planning and execution, and performance evaluation. Each question was scored on a 5-point Likert scale, and a high score indicated that the participants had a high level of creative problem-solving ability. For creative problem-solving ability, the Cronbach's alpha value was 0.94.

4) Collaborative self-efficacy

A tool developed by Alavi and McCormick¹⁶⁾ was used to measure the variables of collaborative self-efficacy. A total of 19 questions was developed for the following sub-factors: opinion consolidation, opinion assessment, opinion exchange, and exhibition of leadership. Each question was scored on a 5-point Likert scale, and a high score indicated that the participants had a high collaborative self-efficacy. For collaborative self-efficacy, the Cronbach's alpha value was 0.94.

5) Work ability

A tool developed and modified by Kim and Hwang¹⁷⁾ and Kim and Han¹⁸⁾ was used to measure the variables of work ability. A total of 26 questions was developed for the

following sub-factors, ability and attitude. Each question was scored on a 5-point Likert scale, and a high score indicated that the participants had a high level of work ability. For work ability, the Cronbach's alpha value was 0.96.

3. Data analysis

The data collected in this study were analyzed using the SPSS software version 25.0 (IBM Corp., Armonk, NY, USA) and were tested at a significance level of 0.05. For

Table 2. 4C Core Competence and Work Level of Dental Hygienists (n=190)

Classification	Category	Mean±standard deviation
Communication ability	Interpreting Ability	3.50±0.35
	Ability to perform roles	3.46±0.38
	Self-presentation ability	3.29±0.52
	Ability to set goals	3.04±0.63
	Message conversion ability	3.39±0.59
	Total	3.34±0.33
Critical thinking	Sound skepticism	3.40±0.65
	Intellectual fairness	3.58±0.60
	Objectivity	3.79±0.67
	Systemicity	2.99±0.77
	Prudence	3.50±0.74
	Intellectual passion	3.31±0.70
	Confidence	3.28±0.70
	Total	3.41±0.46
Creative problem-solving	Clarification of problem	3.47±0.54
	Cause analysis	3.40±0.39
	Alternative development	3.39±0.49
	Planning	3.28±0.57
	Performance evaluation	3.45±0.54
	Total	3.40±0.41
Collaborative self-efficacy	Opinion integration	3.22±0.61
	Opinion evaluation	3.20±0.69
	Opinion exchange	3.42±0.59
	Exerting leadership	3.24±0.64
	Total	3.27±0.54
Work ability Ability	Professionalism	3.41±0.63
	Creativity	3.35±0.67
	Understanding judgment	3.67±0.69
	Total	3.48±0.60
Attitude	Cooperation	3.58±0.68
	Work	3.95±0.70
	Customer orientation	3.91±0.65
	Total	3.81±0.60
Total		3.65±0.56

Table 1. General Characteristics (n=190)

Classification	Category	n (%)
Age (y)	≤25	91 (47.9)
	26~29	43 (22.6)
	≥30	56 (29.5)
Marital status	Single	137 (72.1)
	Married	53 (27.9)
Workplace type	Dental clinic	100 (52.6)
	Dental hospital	88 (46.3)
	General hospital	2 (1.1)
Job position	Regular dental hygienist	134 (70.5)
	Mid-level manager	36 (18.9)
	Senior manager	15 (7.9)
	Others	5 (2.6)
Clinical experience	<5year	100 (52.6)
	5~9 year	51 (26.8)
	≥10 year	39 (20.5)

the general characteristics of the dental hygienists, frequency and percentage were calculated, and the level of the 4C core competencies and work ability of the dental hygienists were calculated using means and standard deviations. A multiple regression analysis was conducted to analyze the effects of the 4C core competencies on work ability.

Results

1. General characteristics of the participants

Table 1 shows the general characteristics of the study participants. The age groups were as follows: 25 years (47.9%), 30 years (29.5%), and 26~29 years (22.6%). Moreover, 27.9% of the participants were married, whereas 72.1% were not. The types of workplace were dental clinics (52.6%), dental hospitals (46.3%), and general hospitals (1.1%). In terms of job positions, regular dental hygienists (70.5%) had, the highest proportion, followed by mid-level managers (18.9%), senior managers (7.9%), and other types of jobs (2.6%). Regarding clinical experience, participants with <5 years of experience (52.6%) had the highest proportion, followed by those with 5~9 years (26.8%) and ≥10 years of experience (20.5%).

2. 4C core competency and work ability levels of dental hygienists

Table 2 depicts the 4C core competency and work ability levels of dental hygienists. The mean scores for the 4C core competency levels of the dental hygienists were as

follows: communication ability 3.34, critical thinking ability 3.41, creative problem-solving ability 3.40, and collaborative self-efficacy 3.27. Meanwhile, the mean score for work ability level was 3.65. Among the sub-factors of communication ability, interpretation ability had, the highest score at 3.50, and among the sub-factors of critical thinking ability, objectivity had scored the highest score at, 3.79 points. And among the sub-factors of creative problem-solving ability, problem clarification had the highest score at 3.47 points, and among the sub-factors of collaborative self-efficacy, both opinion exchange and leadership exhibition had the highest scores at 3.42. Regarding the sub-factors of work ability, the scores for attitude and ability were 3.81 and 3.48, respectively. Regarding the sub-factors of attitude, the score for work attitude was 3.95, and among the sub-factors of ability, understanding and judgment had the highest score at 3.67 points.

opinion exchange and leadership exhibition both received 3.42 points, the highest score. Among the sub-factors of work ability, attitude and ability showed 3.81 points and 3.48 points, respectively. Among the sub-factors of attitude, work attitude scored 3.95 points, while among the sub-factors of ability, understanding and judgment showed the highest score of 3.67 points.

3. Factors of the 4C competencies affecting work ability

Table 3 shows the factors of the 4C core competencies affecting work ability. The linear regression model showed

Table 3. Factors of 4C Core Competence Affecting Work Ability

Independence variable	Dependence variable			t	p-value	VIF
	B	SE	EXP (β)			
4C core competence						
Constant	0.106	0.314		0.338		
Communication ability	0.524	0.116	0.313	4.515	<0.001	1.665
Critical thinking ability	0.141	0.108	0.117	1.299	0.196	2.811
Creative problem-solving ability	0.051	0.118	0.038	0.430	0.668	2.654
Collaborative self-efficacy	0.348	0.076	0.339	4.578	<0.001	1.905

$R^2=0.466$, adjusted $R^2=0.454$, $F=40.343$, $p<0.001$, Durbin-Watson=1.711

The data were analysed by the multiple regression analysis.

Do not show variables that are not statistically significant ($p>0.05$).

VIF: variance inflation factor.

a significant relationship between the factors and work ability ($F=40.343, p<0.001$), with an explanatory power of 45.4%. The significant predictive factors of work ability were communication ability ($t=4.515, p<0.001$) and collaborative self-efficacy ($t=4.578, p<0.001$).

4. Influence of the 4C core competency factors on work ability

Table 4 shows the influence of the 4C core competencies factors on work ability. The linear regression model showed a significant relationship between the factors and work ability ($F=17.812, p<0.001$), with an explanatory power of 47.1%. The significant predictive factors of work ability were opinion exchange ($t=4.063, p<0.001$), confidence ($t=2.233, p<0.05$), sound skepticism ($t=1.932, p<0.01$), and ability to perform roles ($t=2.460, p<0.05$).

Discussion

Dental hygienists should accept changes and respond to novel situations to prepare for future dental care workplaces in the Fourth Industrial Revolution¹⁹. Competencies must be developed to ensure the work abilities required in the

Fourth Industrial Revolution, and among the 4C core competencies, communication ability, critical thinking ability, creative problem-solving ability, and collaborative self-efficacy are important. Therefore, the current study investigated the effects of the 4C core competencies on work ability among dental hygienists.

In terms of the 4C core competencies of the dental hygienists, the average score for communication ability was 3.34, and among the sub-factors of communication ability, interpretation ability had the highest average score, followed by role-performing ability, message-transition ability, self-presentation ability, and goal-setting ability. Interpretation ability conveys meaning through communication that suits the interlocutor's environment¹⁴. Moreover, because dental hygienists listen and pay attention to the patients when performing their work, the average score for interpretation ability is high⁷. The communication ability of dental hygienists is an important competency required to perform the role of mid-level managers. To improve the communication ability of dental hygienists, learners should establish a team and devise solutions for existing problems within a given time and implement them on their own, which results to sharing experiences. Thus, the level of communication ability is increased through interactions

Table 4. Influence of 4C Core Competence Item Factors on Work Ability

Independence variable	Dependence variable			t	p-value	VIF
	B	SE	EXP (β)			
4C core competence						
Constant	0.349	0.347		1.006	0.316	
Ability to perform roles	0.205	0.083	0.139	2.460	0.015	11.14
Ability to set goals	0.108	0.060	0.122	1.792	0.075	1.64
Message conversion ability	0.102	0.065	0.108	1.577	0.116	1.67
Sound skepticism	0.098	0.051	0.114	1.932	0.055	1.23
Intellectual fairness	0.094	0.059	0.100	1.593	0.113	1.41
Intellectual passion	0.071	0.058	0.090	1.238	0.217	1.86
Confidence	0.128	0.057	0.161	2.233	0.027	1.85
Planning	0.072	0.790	0.730	0.901	0.369	2.33
Performance evaluation	0.042	0.086	0.041	0.492	0.623	2.52
Opinion exchange	0.255	0.063	0.271	4.063	<0.001	1.58

$R^2=0.499$, adjusted $R^2=0.471$, $F=17.812$, $p<0.001$, Durbin-Watson=1.706
 The data were analysed by the multiple regression analysis.
 Do not show variables that are not statistically significant ($p > 0.05$).
 VIF: variance inflation factor.

with colleagues when collecting, analyzing, and using data to solve a problem²⁰⁾.

The average score for critical thinking ability was 3.41, and among its sub-factors, objectivity had the highest average score, followed by intellectual fairness, prudence, healthy skepticism, intellectual passion, self-confidence, and systematicity. Yoo et al.²¹⁾ has reported that propensity for objectivity in problem-solving is required when a nurse encounters a challenging situation. Similarly, dental hygienists may solve problems based on valid grounds. Because critical thinking ability affects fast and efficient decision-making, it is considered crucial for dental hygienists who deal with changing medical environments and a variety of patients.

Similarly, the average score for creative problem-solving ability was 3.40, and among its sub-factors, problem clarification had the highest score, followed by performance evaluation, causal analysis, alternative development, and planning and execution. Kim and Han¹⁰⁾ have shown that the problem-solving abilities of nurses affect the improvement of their critical thinking for fast and efficient decision-making. Accordingly, improvement in the creative problem-solving abilities of dental hygienists has positive effects on critical thinking ability.

Moreover, the average score for collaborative self-efficacy was 3.27, and among its sub-factors, opinion exchange had the highest score, followed by leadership exhibition, opinion consolidation, and opinion assessment. Cho and Moon²²⁾ and Kim et al.²³⁾ have shown that self-efficacy affects job satisfaction and organizational commitment. As the level of job satisfaction and organizational commitment increases, the level of work ability also increases, which in turn can yield high-quality medical services for patients and can positively affect the medical service satisfaction of patients.

The average score for work ability was 3.65, and among its sub-factors, the average scores for attitude and ability were 3.65 and 3.48. In a previous study that has investigated the effect of self-leadership on organizational effectiveness and work ability among dental hygienists¹⁸⁾, the average score for work ability is 3.70, and in terms of its sub-factors, the average scores for attitude and ability are 3.88 and 3.46 points, respectively. These results are similar

to those of the current study. Among the sub-factors of attitude, work attitude had the highest average score, followed by customer orientation and cooperation, and among the sub-factors of ability, understanding and judgment had the highest average score, followed by expertise and creativity. The score was higher for attitude than for ability because the research tool was self-administered and the subjective evaluation of ability was more difficult than that of attitude. Furthermore, dental hygienists should develop their work ability while coping up with changes because the scope and role of work ability expand with social change.

The factors of the 4C core competencies of dental hygienists that affect work ability were communication ability ($p < 0.001$) and collaborative self-efficacy ($p < 0.001$). Although critical thinking ability and creative problem-solving ability did not affect work ability, the sub-factors of each affected work ability. To improve the work ability of dental hygienists, it should be applied to communicative workplace training and seminars based on participatory education programs. A program is also required for experienced educators in the workplace.

The present study had some limitations. That is, the results cannot be generalized because the study was conducted on dental hygienists in Busan, Ulsan, and Gyeongsangnam province. Moreover, because no previous study has specifically investigated the relationship between the 4C core competencies and work ability among dental hygienists, it was difficult to objectively compare and explain the results of the current study. Therefore, a follow-up research must be conducted to expand the research targets and regions and to investigate the development process of educational programs and effective educational methods that can improve the respective factors.

Hence, the 4C core competencies were important factors that affect the development of the work ability of dental hygienists. Programs that can be applied to trainings at work, refresher trainings, and seminars should be developed in the form of problem-solving-oriented participatory education, which can increase the level of the 4C core competencies, rather than conventional theoretical education. As a result, the work ability of dental hygienists

will improve, and they can then deal with changes in the medical environment caused by the Fourth Industrial Revolution.

Notes

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Ethical approval

This study was approved by the institutional review board of Silla University (IRB No. 1041449-201810-HR-002).

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