International Journal on Advanced Science Engineering Information Technology

Vol.7 (2017) No. 5
ISSN: 2088-5334

Analysis of Recognition and Educational Needs on Competency of Secondary School Informatics Teachers

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***Abstract*— Recently, efforts have been made to enhance educational competency based on Computational Thinking (CT) in relation to informatics education at home and abroad. Although many informatics teachers training programs are steadily operated in order to cultivate the education capacity in response to the changing demands of the times, this is done without acceptance of an opinion process of informatics teachers' educational needs. Therefore, this study analyzed recognition and educational needs based on the competency model developed for the informatics teachers in secondary school. Educational needs were analyzed using Borich's needs formula. The results of the study are as follows: First, the average of Required Competency Level (RCL) of each competency-unit was higher than average of Present Competency Level (PCL) and there were statistically significant differences between RCL and PCL. Secondly, the educational need of each competency-unit was highest in 'Informatics Teaching and Learning Strategy Establishment and Operation'. Thirdly, the educational needs of Knowledge domain showed the highest educational needs in the competencies of the 'Informatics Teaching and Learning Strategy Establishment and Operation' obtaining more than 7 points. Finally, the educational needs of Skill domain took the 1st to 3rd priorities and indicated higher in the competencies of the same competency-unit as Knowledge domain.**

***Keywords*— educational needs; competency; informatics; teacher training**

I. INTRODUCTION

Many countries around the world have been making efforts to strengthen education to increase students' Computational Thinking (CT) competencies by designating Computer Science as a national curriculum in recent years [1]. In the UK, the curriculum was revised to encompass Computational Thinking, Information Technology, and Digital Literacy. In addition, since September 2014, 'Computing' has been designated as a national curriculum and it has been taken as a required course at elementary, middle, and high schools [2].

In accordance with this trend, the Ministry of Education in South Korea announced the contents of strengthening Software (SW) education through 'SW Education Operation Guidelines' and '2015 Liberal Art and Natural Sciences Integrated Curriculum Frameworks' [3], [4]. And the national curriculum revised in 2015 emphasizes CT-based SW education activities and collaborative problem-solving competency-based education by selecting Information Culture Literacy, CT, and Collaborative Problem-Solving Ability as subject competencies [5]–[9].

Teachers' professionalism has the greatest impact on developing students' competencies in the changing educational environment and paradigm [10].

Therefore, teachers should try to equip their educational competency in terms of Knowledge, Skill and Attitude through various educational activities as educational experts [11], [12].

In particular, informatics teachers must continually try to cultivate educational competency to teach changed contents, forms, and tools for rapidly changing informatics subject to rapidly changing computing environments [13]. The Ministry of Education and the Ministry of Science, ICT and Future Planning are considering strengthening the SW educational competency of teachers to enhance the quality of informatics education. In other words, they provide SW intensive training for about 6,000 elementary school teachers and train as core teachers. In 2018, SW education job training will expand to about 60,000, 30% of all teachers. In addition, they are currently planning SW intensive training for all secondary school informatics teachers [14].

Many informatics teachers training programs are steadily operated in order to cultivate the education capacity in

response to the changing demands of the times. But most of them are carried out through programs that focus on the contents and educational tools most frequently mentioned in recent years, without a systematic training program model. Also, there is no investigation or analysis about the process of collecting opinions on the educational needs of informatics teachers that should be considered as the top priority [15].

The purpose of this study is to identify Required Competency Level (RCL) and Present Competency Level (PCL), which are recognized by informatics teachers based on the competency model of secondary school informatics teachers developed through competency modelling and to analyze the educational needs.

II. Material and Method

A. Participants

This study was carried out on the teachers of secondary school in-service informatics teachers in seven regions including Seoul, Gyeonggi, and Jeju. A total of 111 copies were distributed for data collection, and 102 questionnaires that responded faithfully were used for analysis. Table 1 shows the demographic characteristics of the survey respondents about Gender, Age, and Career.

TABLE I
Demographic Data about the Respondents

		N (%)
Gender	Male	39 (38.2)
	Female	63 (61.8)
Age	Under 29	4 (3.9)
	30 to 39	34 (33.3)
	40 to 49	55 (54.0)
	50 to 59	9 (8.8)
Career	Less than 5	10 (9.8)
	6 to 10	10 (9.8)
	11 to 15	44 (43.1)
	16 to 20	21 (20.6)
	More than 21	17 (16.7)
Total		102 (100.0)

B. Procedure and Analysis

This study investigated and analyzed the educational needs of secondary school informatics teachers in the following process.

First, in order to survey the educational needs of secondary informatics teachers, questionnaires were constructed based on competency model derived from the study of Ko et al. [16]. The questionnaire consisted of 5 questions related to demographics including Gender, Age, and Career, and consisted of a total of 91 competency questions.

Table 2 shows the contents of the 7 competency-units and the composition of the questions by Knowledge and Skill domain components. To measure RCL and PCL of each question, the 5-point Likert scale was used.

In order to verify the content validity of the questionnaire, we reviewed and modified the questionnaire through a group of experts consisting of five (1 professor in informatics major, 1 doctoral student in informatics major, 1 in-service informatics teacher, 2 professors in pedagogical major).

TABLE II
Composition of the Questionnaire

Competency-unit	**Components (Numbers of Competencies)**
Data Collection/Analysis/Representation	Knowledge (7) Skill (9)
Abstraction and Algorithm design	Knowledge (9) Skill (11)
Programming	Knowledge (5) Skill (11)
Computing System Configuration	Knowledge (2) Skill (8)
Informatics Teaching and Learning Strategy Establishment and Operation	Knowledge (3) Skill (7)
Informatics Subject Evaluation Plan Establish and Implement	Knowledge (6) Skill (7)
Information Culture	Knowledge (2) Skill (4)

Next, we carried out two surveys to collect data on educational needs from Feb 22, 2016, to Feb 24, 2016.

The collected data were analysed using the SPSS Statistics 18.0 program. And the reliability of the questionnaire used in this study was verified by calculating Cronbach's α coefficient. As a result of the reliability analysis of 91 competency questions, Cronbach's α value was .984, which showed high reliability.

The mean of the RCL and PCL of each competency recognized by the informatics teachers was analyzed using Descriptive statistics. Also, we analyzed whether there is a significant difference between RCL and PCL using Paired-samples t-test.

Typical educational needs analysis methods used in social science are Borich's needs analysis, IPA (Importance-Performance Analysis) analysis, and The Locus for Focus Model analysis [17]–[19].

In this study, we analyzed the educational needs and prioritized using Borich's needs formula.

$$\text{Borich's needs} = \frac{\sum(RCL-PCL)\times\overline{RCL}}{N}$$

RCL(Required Competency Level) : Each individual's importance score

PCL(Present Competency Level) : Each individual's performance score

$\overline{RCL}$ *: Average score of importance by each competency*

N : Total number of cases

Fig. 1 Borich's needs formula

III. Results and Discussion

A. Mean of the RCL and PCL by Competency-Units

Table 3 shows the analysis results of the mean and standard deviation of the RCL and PCL of the competencies according to the 7 competency-units.

In the case of the mean of the RCL, the mean of 'Informatics Teaching and Learning Strategy Establishment and Operation' showed the highest score of 4.53, but 'Computing System Configuration' showed the lowest score of 4.18.

In the case mean of the PCL, 'Information Culture' showed the highest score of 3.55, but 'Computing System Configuration' showed the lowest score of 2.98.

Generally, the mean of the RCL of each competency-unit is higher than the mean of the PCL. In other words, this suggests that secondary school informatics teachers perceive that all 7 competency-units are important as educational competencies, but show low performance.

As a result of the t-test, it was found that there was a statistically significant difference between the t values of all competency-units at significance level .001. In other words, this means that all 7 competency-units are important and necessary as educational competency.

B. Educational Needs by Competency-Units

As a result of analyzing the educational needs and priorities of 7 competency-units, the educational needs of the 'Informatics Teaching and Learning Strategy Establishment and Operation' showed the highest score of 6.769.

Then, priority was given in the following order. 'Abstraction and Algorithm design' (5.573), 'Programming' (5.156), 'Computing System Configuration' (5.075), 'Informatics Subject Evaluation Plan Establish and Implement' (4.548). Finally, the educational needs of 'Data Collection/Analysis/Representation' (3.894) showed the lowest priority.

In particular, the reason why the educational needs of 'Information Culture' showed relatively low is that the mean of the RCL (4.52) and the mean of the PCL (3.55) are both high. In other words, it is recognized that secondary school informatics teachers are important for 'Information Culture' and at the same time they show high performance.

Fig. 2 shows the results of the mean(RCL and PCL) and educational needs in Table 3.

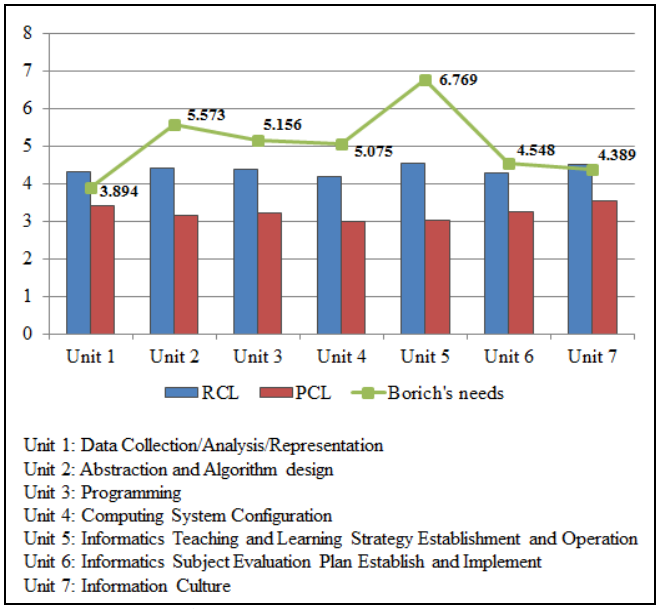

Fig. 2 Comparison of the mean and educational needs by competency-units

C. Educational Needs by Components

In order to analyze the educational needs of each competency according to the components, we divided them into Knowledge and Skill domain.

TABLE III
EDUCATIONAL NEEDS AND PRIORITIES BY COMPETENCY-UNIT

Competency-unit	RCL		PCL		RCL-PCL		t	Borich's needs	Priority
	M	SD	M	SD	M	SD			
Data Collection/Analysis/Representation	4.33	.53	3.43	.60	.90	.67	13.437***	3.894	7
Abstraction and Algorithm design	4.42	.48	3.17	.70	1.25	.74	17.149***	5.573	2
Programming	4.39	.50	3.22	.75	1.17	.79	14.989***	5.156	3
Computing System Configuration	4.18	.55	2.98	.70	1.20	.76	15.995***	5.075	4
Informatics Teaching and Learning Strategy Establishment and Operation	4.53	.46	3.04	.75	1.49	.77	19.468***	6.769	1
Informatics Subject Evaluation Plan Establish and Implement	4.30	.56	3.24	.74	1.06	.74	14.484***	4.548	5
Information Culture	4.52	.49	3.55	.82	.97	.83	11.733***	4.389	6

***p<.001

TABLE IV
EDUCATIONAL NEEDS AND PRIORITIES IN THE DOMAIN OF KNOWLEDGE

Priority	Borich's needs	Competency-unit/Competency	RCL		PCL		RCL-PCL		t
			M	SD	M	SD	M	SD	
1	7.555	**Informatics Teaching and Learning Strategy Establishment and Operation** - Teaching and Learning Model and Method: Unplugged, STEAM, etc.	4.48	.59	2.79	.96	1.69	1.06	16.033***
2	7.539	**Informatics Teaching and Learning Strategy Establishment and Operation** - Teaching and Learning Tools: Board game-related programming education, etc.	4.47	.63	2.78	1.00	1.69	1.09	15.627***
3	6.514	**Data Collection/Analysis/Representation** - Data Analysis: Big Data Concept/Analysis/ Utilization, etc.	4.52	.69	3.08	.86	1.44	1.00	14.545***
4	6.344	**Abstraction and Algorithm design** - Problem Decomposition: Classification/ Analysis/Division of problem, Current status, Goal status, etc.	4.37	.67	2.92	.88	1.45	1.00	14.636***
5	6.158	**Informatics Teaching and Learning Strategy Establishment and Operation** - Teaching and Learning Model and Method: (Creative) Problem solving, etc.	4.39	.72	2.99	.92	1.40	1.00	14.193***

***p<.001

Table 4 and Table 5 show the analysis results of the mean of the RCL and PCL and the educational needs by classifying 91 competencies into Knowledge and Skill domain, respectively. The results of the analysis show the educational needs of the 1st to 5th priority.

As a result of analyzing the educational needs and priorities according to the Knowledge domain, the educational needs of the 'Teaching and Learning Model and Method' competency in the competency-unit of 'Informatics Teaching and Learning Strategy Establishment and Operation' showed the highest score of 7.555.

Then, priority was given in the following order. 'Teaching and Learning Tools' (7.539), 'Data Analysis related to Big Data' (6.514), 'Problem Decomposition' (6.344), another 'Teaching and Learning Model and Method' (6.158).

As a result of the t-test, it was found that there was a statistically significant difference between the t values of all competencies from 1st to 5th priority at significance level .001.

The analysis of the educational needs of competencies according to the Knowledge domain shows some notable points.

First, the educational needs of the competencies in the competency-unit of 'Informatics Teaching and Learning Strategy Establishment and Operation' were relatively higher than those of the other competency-unit. In other words, this suggests that secondary school informatics teachers are the first priority competencies to be considered in acquiring knowledge.

Next, the educational needs of the 'Data Analysis related to Big Data' competency in the competency-unit of 'Data Collection/Analysis/Representation' showed the highest mean of both RCL and PCL. The results of the analysis of the educational needs showed high priority.

Recently, Big Data has been attracting attention as one of the fourth industrial revolutions with AI, IoT, Cloud Computing, Robot Engineering, and 3D Printing. In other words, this suggests that secondary school informatics teachers are increasingly aware of the importance of Big Data, and at the same time, they are collecting, analysing and utilizing Big Data and applying it variously to education.

As a result of analyzing the educational needs and priorities according to the Skill domain, the educational needs of the 'Skill that can converge various disciplines focusing on CT' competency in the competency-unit of 'Informatics Teaching and Learning Strategy Establishment and Operation' showed the highest score of 7.411.

Then, priority was given in the following order. 'Skill to engage, interact, share to achieve shared learning goals among learners in Collaborative Project Learning' (7.198), 'Skill to discover various examples of informatics subject that can be seen in real life and apply them class' (7.107), 'Skill that enables learners to design and develop creations of various ideas through Collaborative Project Learning' (7.107)'. Finally, the educational needs of 'Skill to design efficient algorithms to solve complex problems in other fields of study' competency in the competency-unit of 'Abstraction and Algorithm design' showed a higher score of 6.955.

As a result of the t-test, it was found that there was a statistically significant difference between the t values of all competencies from 1st to 5th priority at significance level .001.

TABLE V
EDUCATIONAL NEEDS AND PRIORITIES IN THE DOMAIN OF SKILL

Priority	Borich's needs	Competency-unit/Competency	RCL		PCL		RCL-PCL		t
			M	SD	M	SD	M	SD	
1	7.411	**Informatics Teaching and Learning Strategy Establishment and Operation** - Skill that can converge various disciplines focusing on CT	4.64	.54	3.04	.84	1.60	.88	18.305***
2	7.198	**Informatics Teaching and Learning Strategy Establishment and Operation** - Skill to engage, interact, share to achieve shared learning goals among learners in Collaborative Project Learning	4.68	.53	3.14	.90	1.54	.97	16.000***
3	7.107	**Informatics Teaching and Learning Strategy Establishment and Operation** - Skill to discover various examples of informatics subject that can be seen in real life and apply them to class	4.65	.57	3.12	.88	1.53	.94	16.417***
3	7.107	**Informatics Teaching and Learning Strategy Establishment and Operation** - Skill that enables learners to design and develop creations of various ideas through Collaborative Project Learning	4.65	.57	3.12	.84	1.53	.97	15.892***
5	6.955	**Abstraction and Algorithm design** - Algorithm: Skill to design efficient algorithms to solve complex problems in other fields of study	4.48	.71	2.94	.88	1.54	1.13	13.829***

***p<.001

As a result of analyzing the educational needs of competencies according to the Skill domain, the educational needs of the competencies in the competency-unit of 'Informatics Teaching and Learning Strategy Establishment and Operation' were relatively higher than those of the other competency-unit.

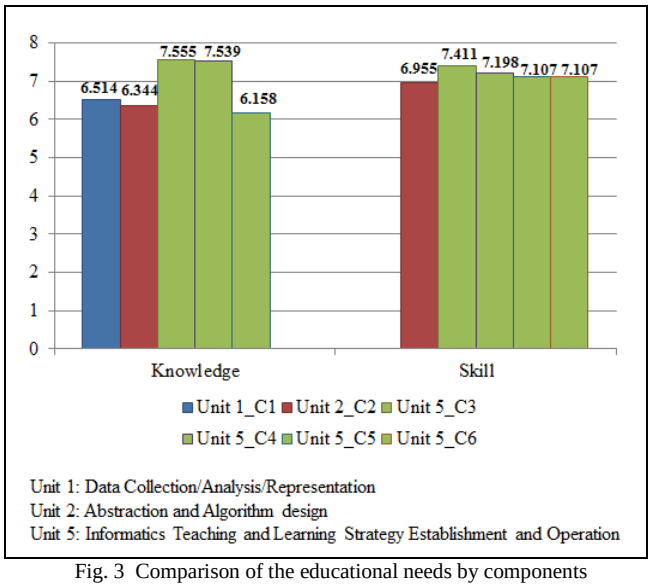

Fig. 3 Comparison of the educational needs by components

This result is identical to the result of the Knowledge domain, as shown in Fig. 3. In other words, this means that secondary school informatics teachers are striving to establish and operate a continuous teaching and learning strategy plan for effective teaching and learning in line with rapidly changing informatics education environment and curriculum characteristics.

In particular, the informatics subject of middle school will be converted into the required subject from 2018. Because of this change in the curriculum and the perception of students who are currently experiencing difficulties in SW education, the competencies in the competency-unit of the 'Informatics Teaching and Learning Strategy Establishment and Operations' is more important for secondary school informatics teachers.

IV. CONCLUSIONS

In this study, we identified the RCL and PCL recognized by the informatics teachers and analyzed educational needs based on the competency model of the secondary school informatics teachers developed through competency modeling.

The conclusions and suggestions based on the results of the previous research are as follows.

First, as a result of analyzing the mean and the difference verification by the competency-units, the mean of each RCL of 7 competency-units was higher than the mean of the PCL.

As a result of verifying the difference between RCL and PCL, all 7 competency-units showed a statistically significant difference at significance level .001.

Secondly, as a result of analyzing the educational needs and priorities of 7 competency-units were as follows. 'Informatics Teaching and Learning Strategy Establishment and Operation' (6.769), 'Abstraction and Algorithm design' (5.573), 'Programming' (5.156), 'Computing System Configuration' (5.075), 'Informatics Subject Evaluation Plan Establish and Implement' (4.548), 'Information Culture' (4.389), 'Data Collection/Analysis/Representation' (3.894).

Thirdly, the results of analyzing the educational needs and priorities of the competencies of each component, which are divided into Knowledge and Skill domains, are as follows.

In the Knowledge domain, the competencies of the 'Informatics Teaching and Learning Strategy Establishment and Operation' competency-units were ranked 1st ('Teaching and Learning Model and Method', 7.555), 2nd ('Teaching and Learning Tools', 7.539), and 5th ('Teaching and Learning Model and Method', 6.158) respectively.

In the Skill domain, competencies in the same competency-units as the Knowledge domain were ranked 1st ('Skill that can converge various disciplines focusing on CT', 7.411), 2nd ('Skill to engage, interact, share to achieve shared learning goals among learners in Collaborative Project Learning', 7.198), and 3rd ('Skill to discover various examples of informatics subject that can be seen in real life and apply them to class', 7.107, 'Skill that enables learners to design and develop creations of various ideas through Collaborative Project Learning', 7.107), respectively.

In summary, the educational needs of the competencies of 'Informatics Teaching and Learning Strategy Establishment and Operation' by competency-units and components were higher than those of other competencies.

Based on the above conclusions, the direction of future works for strengthening the educational competency of the secondary school informatics teachers is as follows.

First, further analysis using The Locus for Focus Model is needed. The Locus for Focus Model visualizes the level of educational needs through the mean value of importance, the difference between importance and performance. And this model provides information on which ranking to take into account in order of priority from the Borich's needs analysis.

For this reason, it is necessary to derive more systematic and practical educational needs outcomes through this model analysis in the future.

Secondly, the competencies of the competency model of the currently developed secondary school informatics teachers are not subdivided by type.

For example, further works are needed on the competency system that subdivides competencies into more specific types such as core competencies, general competencies, and common competencies.

Finally, if the contents development research of the secondary school informatics teachers' training program is carried out based on the educational needs derived from this study in the future, it is expected that it will be a more systematic and effective training program.

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