Construction and Validation of a Cognitive Presence Scale for Measuring Online Learners' Engagement

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Cognitive presence, a sense of "being there" cognitively, has recently been considered as an important indicator for students' engagement in e-learning. There is, however, no widely accepted scale to measure the level of cognitive presence since most studies have put their effort to set and clarify the conceptual framework with qualitative methodology. This study reviewed existing theories on cognitive presence and related fields extensively and developed a new self-report scale for measuring the conceived level of cognitive presence. The reliability and validity of the scale was tested against 723 undergraduate students in two consecutive studies, 418 in the preliminary and 305 in the follow-up study. Three major constructs to measure the perceived level of cognitive presence were: 1) clear understanding, 2) knowledge construction, and 3) learning management. This paper reports the final results of the two independent studies.

Keywords : cognitive presence, e-learning, online learners' engagement

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Introduction

As Illeris (2003) indicated, there are three dimensions of learning: cognitive, emotional, and social. In any learning process, truly engaged learners are intellectually, socially, and emotively involved in their learning tasks (Wang & Kang, 2005). Among three dimensions, the cognitive dimension represents how we transform information into knowledge through learning process. It includes the information processing steps as well as domains of reflection, meta-cognition, and self-regulations (Garrison, Anderson, & Archer, 2003). Recently studies related to online learning have begun to shift their focus to better understand the unique needs associated with online learners. Online learning began to embed the properties that can provide to support deep and meaningful learning through reflective thinking.

The shift is increasing the importance of cognitive engagement in online learning (Richardson & Newby, 2006). One of the crucial factors for engagement in online learning is considered to be the level of perceived cognitive presence. In other words, engaged learners would naturally possess high level of perceived cognitive presence in an e-learning context. Cognitive presence, a sense of "being there" cognitively, has been mainly researched by constructivists who stated that cognitive presence reflects higher-order knowledge acquisition and application in online learning (Garrison, Anderson, & Archer, 2004). Cognitive presence is also an important factor in facilitating learners' engagement and in affecting a learner's level of achievement and satisfaction (Wang & Kang, 2005).

Despite the importance of cognitive presence for successful online learning, there is no widely accepted measurement scale. Therefore, a new scale for measuring cognitive presence was developed, based on the review of existing theories on the cognitive factors activating learners' engagement in an online learning environment. In this study, a preliminary study was conducted with 418 undergraduate students in an e-learning environment. The reliability and validity of the new scale were retested in the follow-up study with 305 students. This paper

reports the final results of both studies and presents the validated scale of cognitive presence in online environments.

Theoretical Framework

The concept of 'presence' and 'cognitive presence'

The term presence refers to 'the sense of being in an environment.' (Steuer, 1992, p.76). This definition of presence is used in the field of communication research. Along with this terminology, the term telepresence has been used in the field of virtual reality research. Telepresence is defined as 'the sense of being in an environment, generated by natural or mediated means' or 'the extent to which one feels present in the mediated environment, rather than in the immediate physical environment' (Steuer, 1992, p.76). As online learning has become the one of major research topics in the field of educational technology, the concept of telepresence have drawn the attention from researchers in the field.

The concept of presence in educational technology has expanded to describe the online learning experience by several researchers. Online learning has the properties that can provide to support deep learning through reflective thinking. The properties include domains of information processing, reflection, meta-cognition, and self-regulation. Among the studies on presence, there are two important models that attempted to comprehensively describe the learners' presence during online learning: the model of Community of Inquiry and the Cybergogy model for Engaged Learning.

Two models: Model of community of inquiry and cybergogy model for engaged learning

The model of Community of Inquiry (CoI), suggested by Garrison, Anderson

and Archer (2000), presents three major presence as elements of an education experience in online learning context. The three major domains of presence are : cognitive presence, social presence, and teaching presence (Figure 1). The CoI model, based on Dewey's (1993) practical inquiry model, asserted that online learning can create cognitive presence resulting in deep learning outcomes. According to Garrison et al., cognitive presence concerns the intellectual ambiance and is related to reflection and discourse. They have defined cognitive presence as the extent to which learners are able to construct and confirm meaning through sustained reflection and discourse in a critical community of inquiry (Garrison et al., 2000).
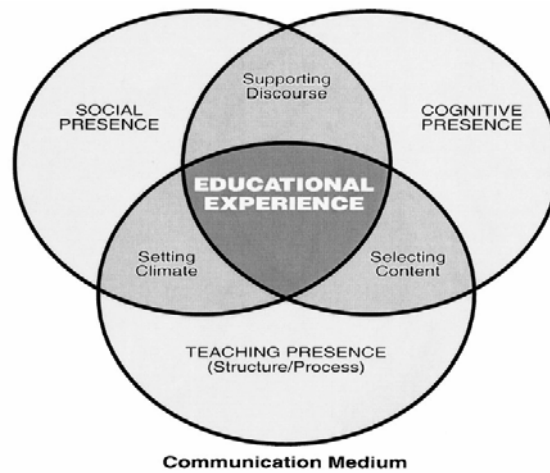

Figure 1. Elements of an educational experience in the model of Community of Inquiry
(Garrison et al., 2000)

In order to assess and to find the evidence of cognitive presence, Garrison et al. (2000) generated indices corresponding to each phase of the practical inquiry model. The indicators for the first phase (triggering events) are recognizing a problem or issue. The second phase (exploration) is a search for related information and therefore it reflects divergent process in making sense of an issue. The third phase (integration) represents a tentative conversion and synthesis connecting ideas to a

possible conclusion. Finally, the fourth phase (resolution) concerns the process of testing the validity of the conclusion. In this model, cognitive presence is the most core aspect of all three. Social presence serves as a supporting means in the process in some way facilitating with help from teaching presence.

More recently, the Cybergogy model for Engaged Learning, proposed by Wang and Kang (2005), presents more comprehensive model including telepresence, teaching presence, cognitive presence, social presence, and emotive presence (See Figure 2). In this model, telepresence refers to the sense of being there during online learning. The level of teaching presence is increasing as learners recognize
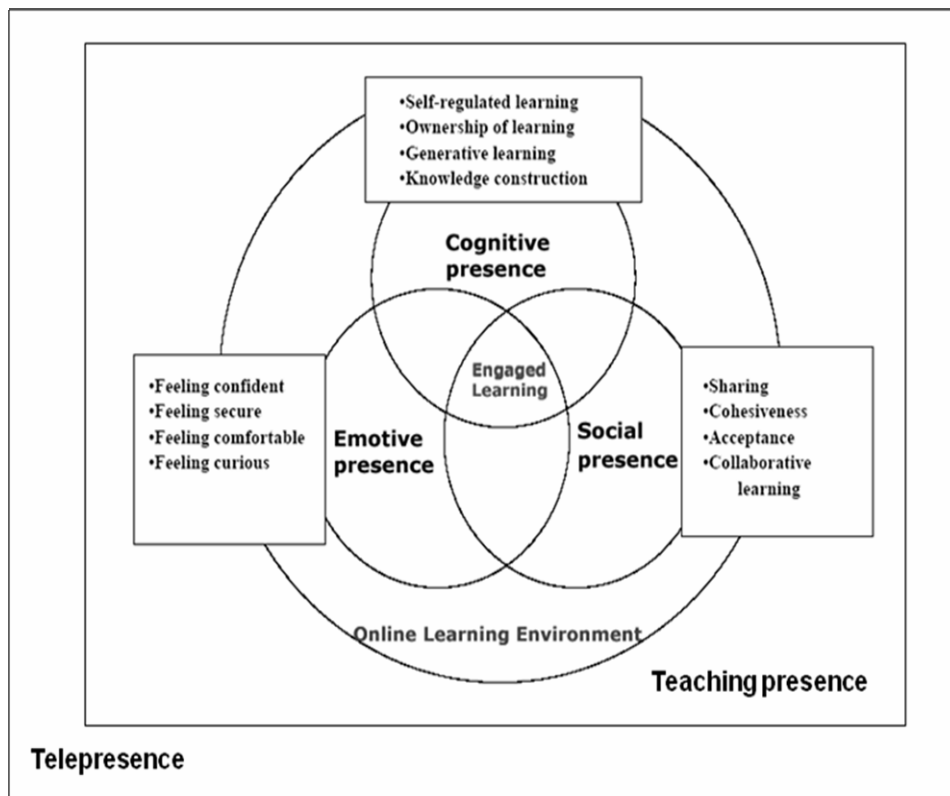

Figure 2. Cybergogy for engaged learning: Increasing the level of presence
(Wang & Kang, 2005)

facilitation of the instructor. The core overlapping domains of presence of this model are cognitive, emotive, and social presence. Researchers have claimed that for teaching to be effective, cognitive presence, emotive presence, and social presence must work together. The model provides ways that instructors can detect learner's engagement during e-Learning. Along with emotive and social presence, cognitive domain relates the ways that learners optimize personal relevance and meaning.

Unlike the model of Community of Inquiry, in the Cybergogy model teaching presence is defined as an independent domain that are affected by the facilitation of instructors. Another difference is that the Cybergogy model presented emotive presence as an independent domain, emphasizing individual state of emotion while learning is executed and replacing teaching presence. Although emotion could be considered as a sub-construct of social presence, a difference between social presence and emotive presence exists. Social presence is based on the relationships among people and emotive presence is perceived based on the emotive state of an individual. What one person expresses and feels even when one belongs to a community is considered as an individual's emotional aspect. Campbell and Cleveland-Innes (2005) also asserted that emotive presence 'has a unique saliency and currency that must be considered outside the social self (p. 4).'

Three constructs of cognitive presence

In the Cybergogy model for Engaged Learning, the concept of cognitive presence is grounded in the theory of cognitive engagement and self-regulated learning theory. According to the cognitive engagement theory (Ryan & Patrick, 2001; Bangert-Drowns & Pyke, 2002), there are three characteristics that engaged learners might share: understanding, constructing, and self-regulating in knowledge construction.

First, learners with a high level of perceived cognitive presence understand

learning contents well. Cognitive engagement is the mobilization of cognitive strategies for interpretive transaction (Bangert-Drowns & Pyke, 2001). In other words, engaged learners are thought to be concerned with their learning tasks more intellectually.

Second, a high level of learners' perceived cognitive presence could facilitate knowledge construction. Knowledge construction is known to have three stages: information acquisition, information transformation, and knowledge construction (Corno & Mandinach, 1983). First, in the information acquisition stage, learners assess their own knowledge structure. Then it stimulates learners' interest to find helpful information. Second, in the information transformation stage, learners select proper information, integrate it with their prior knowledge, and plan for particular actions. Last, in the knowledge construction stage, learners reach at the final destination where the products of knowledge construction are realized.

Third, learners who perceive a high level of cognitive presence manage learning resources freely. Since cognitive engagement is considered as a core variable in a well-developed self-regulating learning process, engaged learners will be able to manage resources, environment and performance well (Mckeachie, Pintrich, Lin, & Smith, 1986). Resource management involves the process of developing well-defined goals and scheduling the course to achieve the best results. Environment management is the development of a physical setting that is helpful to learners. Performance management includes self-effort, self-reinforcement, and persistence (Mckeachie et al., 1986).

The above discussion led to the extraction of three constructs of cognitive presence: clear understanding, knowledge construction, and learning management. Accordingly, the operational definition of cognitive presence in this study is defined as the 'perceived level of clear understanding, knowledge construction, and learning management during e-Learning.' Each construct with its relevant sub-components and related research support is summarized in Table 1.

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Table 1. Theoretical framework for three constructs of cognitive presence

Main constructs	Sub components	Research support
Clear Understanding	• Consistency between content and objective • Organization of content • Articulation of content	Gagne, Yekovich & Yekovich, 1993; Wang & Kang, 2005
Knowledge construction	• Information acquisition • Information transformation • Knowledge construction	Corno & Mandinach, 1983; Wang & Kang, 2005
Learning management	• Time management • Performance management • Environment management	Mckeachie et al., 1986; Zimmerman, 1990; Garrison et al., 2003

Preliminary Study

Participants

In order to measure the validity of the newly developed scale, 482 undergraduate students, enrolled in an online course at a large university in Korea, were targeted for this study. The course title was 'Design of College Life' in liberal arts. All participants were freshmen in the College of Social Science. This class lasted for eight weeks. One week before starting online class, students attended an off-line orientation session that was designed to explain the learning method of online class and to introduce the professor and tutors of the class. In the fourth week, the scale was tested via an online survey. 418 students' responses were collected.

Instrument development

Cognitive presence in this study is operationally defined as the 'perceived level of clear understanding, knowledge construction, and learning management during e-

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Learning'. Through a literature review three major constructs of cognitive presence were identified: clear understanding, knowledge construction, and learning management.

Table 2. Initial items developed for measuring cognitive presence

Main constructs	Sub components	Item_No	Items	Research support
Clear Understanding	Consistency between content and objective	cp_und1	The course is what I expected.	Gagne, Yekovich & Yekovich, 1993; Wang & Kang, 2005
		cp_und2	The course title is consistent with the course contents.	
	Organization of content	cp_und3	I could distinguish important parts from various class contents.	
		cp_und4	I could outline what I learned in the course.	
	Articulation of content	cp_und5	The course content is easy for me to explain.	
		cp_und6	I could discuss what I learned with my classmates.	
Knowledge construction	Information acquisition	cp_knw1	I plan to search for supplemental materials.	Corno & Mandinach, 1983; Wang & Kang, 2005
		cp_knw2	I could select useful materials for the class.	
	Information transformation	cp_knw3	I could use what I learned in the class to do the assignments.	
		cp_knw4	I could make a connection between new information and what I already know.	
	Knowledge construction	cp_knw5	I am learning something new in the class.	
		cp_knw6	I am gaining a new perspective through the class.	
Learning management	Time management	cp_mgm1	I could do assignments by making a plan.	Mckeachie et al., 1986; Zimmerman, 1990; Garrison et al., 2003
		cp_mgm2	I had enough time to perform the tasks.	
	Performance management	cp_mgm3	I am spending enough time on the class.	
		cp_mgm4	I ask the professor or the tutor questions when I do not understand something.	
	Environment management	cp_mgm5	I organize resources for class assignments and activities.	
		cp_mgm6	I can rearrange environment for me to concentrate on my studies.	

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Eighteen items (two items per each sub component) with a five-point Likert scale were initially developed (See Table 2). These items were reviewed for content validity by a senior researcher who has previous experience in cognitive presence related studies. An online survey was conducted and 418 responses were collected. Exploratory factor analysis (EFA) was performed to verify the emergence of the three dimensions of cognitive presence. Principal axis factoring method was used to extract factors. To rotate factors, direct oblimin rotation method was used. Scree plot testing with visual inspection was also used to determine the number of factors to be extracted.

Results

The results of EFA with 18 items yielded three constructs: clear understanding, knowledge construction, and learning management. The reliability of these factors with Cronbach's coefficient alpha yielded .728, .750, .738, respectively. Eight items

Table 3. Emerged factors of cognitive presence (preliminary study, factor loading > .40)

Main constructs	Remaining Item_No	Factor 1	Factor 2	Factor 3	Cronbach's alpha
Clear understanding	cp_und5	.728	.464	.493	.728
	cp_und3	.639	.322	.373	
	cp_und6	.584	.492	.503	
	cp_und4	.566	.335	.287	
Knowledge construction	cp_knw5	.406	.719	.314	.750
	cp_knw6	.441	.701	.449	
Learning management	cp_mgm3	.385	.441	.668	.738
	cp_mgm5	.477	.372	.649	
	cp_mgm1	.478	.351	.633	
	cp_mgm6	.396	.410	.577	

showing loading lower than .40 were removed (Thurston, 1947). The items from the 'Consistency between content and objective', 'Information acquisition', and 'Information acquisition' sub-components were removed. One item from the 'Time management' and 'Performance management' sub- components were removed. As a result, out of 18 initial items 10 items retained. The remaining items with reliability are presented in Table 3.

Follow-up Study

Participants

To revalidate the sub-components of the scale developed in the preliminary study, this scale was retested with 305 undergraduate students. They enrolled in an online course titled 'Design of College Life' in the fall semester of 2006 at a large university in South Korea. The class lasted for eight weeks and the cognitive presence scale was distributed to participants as an online survey during the fourth week.

Instrument development

In order to improve the content validity and reliability of the scale, two new items were added to the 'organization of content' sub component and one new item to the rest 8 sub-components respectively. The 10 remaining items from the preliminary study were reviewed and further refined to improve the clarity of the meaning in each item. As a result, the 27 items were finally prepared for the follow-up study as shown in Table 4.

Table 4. Revised items for measuring cognitive presence (follow-up study)

Main constructs	Sub components	Item_No	Items	Research support
Clear understanding	Consistency between content and objective	cp_und1	The course is that I expected.	Gagne, Yekovich & Yekovich, 1993; Wang & Kang, 2005
		cp_und2	The course title is consistent with the course contents.	
		cp_und3	The course content is what I expected. *	
	Organization of content	cp_und4	I could draw diagrams and graphs with what I learned in the course. *	
		cp_und5	I can reorganize what I learned in the course. *	
		cp_und6	I could outline what I learned in the course.	
	Articulation of content	cp_und7	The course content is easy for me to explain.	
		cp_und8	I could discuss what I learned with my classmates.	
		cp_und9	I could briefly summarize what I learned.*	
Knowledge construction	Information acquisition	cp_knw1	I plan to search for supplemental materials.	Corno & Mandinach, 1983; Wang & Kang, 2005
		cp_knw2	I could select useful materials for the class.	
		cp_knw3	I could collect the information related to the class.*	
	Information transformation	cp_knw4	I could use what I learned in the class to do the assignments.	
		cp_knw5	I could make a connection between new information and what I already know.	
		cp_knw6	I deeply understood what I learned. *	
	Knowledge construction	cp_knw7	I am learning something new in the class.	
		cp_knw8	I am gaining a new perspective through the class.	
		cp_knw9	I could apply what I learned in reality.*	
Learning management	Time management	cp_mgm1	I could do assignments by making a plan.	Mckeachie et al., 1986; Zimmerman, 1990; Garrison et al., 2003
		cp_mgm2	I had enough time to perform the tasks.	
		cp_mgm3	I was not stressful about the assignment due date.*	
	Performance management	cp_mgm4	I am spending enough time on the class.	
		cp_mgm5	I ask the professor or the tutor questions when I do not understand something.	
		cp_mgm6	I know how to be helped.*	
	Environment management	cp_mgm7	I organize resources for class assignments and activities.	
		cp_mgm8	I can rearrange environment for me to concentrate on my studies.	
		cp_mgm9	I could eliminate the obstacles that disturb my studies. *	

(* indicates the new items added in the follow-up study)

The three main constructs of cognitive presence are clear understanding, knowledge construction, and learning management. First, the 'clear understanding' construct has three sub-components: 1) consistency between content and objective, 2) organization of content, 3) articulation of content (Gagne, Yekovich & Yekovich, 1993). For example, the following items were used: 'The course content is what I expected', 'I can reorganize the content that I learned', and so on.

Second, the 'knowledge construction' construct has the following sub-components: 1) information acquisition, 2) information transformation, and 3) knowledge construction (Corno & Mandinach, 1983; Wang & Kang, 2005). For example, the following items were used: 'I could collect the information related to the class', 'I could use what I learned in the class to do the assignments.'

Third, the 'learning management' construct has sub-components: 1) time management, 2) performance management, and 3) environment management (Ryan & Patrick, 2001; Zimmerman, 1990; McKeachie et al., 1986). For example, the following items were used: 'I could do assignments by making a plan', 'I could eliminate the obstacles that disturb my studies.'

27 items were reviewed by a senior researcher for content validity and were modified based on recommendations. The online survey was conducted and 305 responses were collected. Exploratory factor analysis (EFA) was performed to verify the emergence of the three dimensions of cognitive presence. Principal axis factoring method was used to extract factors. To rotate factors, direct oblimin rotation method was used.

Results

The results of EFA with 27 items yielded three constructs: clear understanding, knowledge construction, and learning management. The reliability of these factors with Cronbach's coefficient alpha yielded .816, .828, and .667. The reliability alpha

values of the first two constructs were enhanced although that of the third construct was reduced. Eight items showing loading lower than .40 were removed (Thurston, 1947). First, all three items removed in the 'clear understanding' construct was from the 'consistency between content and objective' sub-component. Second, all nine items were retained in the 'knowledge construction' construct. Lastly, the remaining four items in the 'learning management' construct was the items from the 'time management' and 'environment management' sub-components. As a result, 19 items remained. The final items obtained from the follow-up study are presented in Table 5.

Table 5. Emerged factors of cognitive presence (follow-up study, factor loading > .40)

Main constructs	Remaining Item_No	Factor 1	Factor 2	Factor 3	Cronbach's alpha
Clear understanding	cp_und5	.403	.731	.348	.816
	cp_und9	.509	.726	.253	
	cp_und8	.573	.678	.325	
	cp_und6	.551	.650	.322	
	cp_und7	.533	.596	.296	
	cp_und4	.396	.565	.356	
Knowledge construction	cp_knw4	.702	.499	.421	.828
	cp_knw7	.672	.292	.342	
	cp_knw2	.579	.317	.415	
	cp_knw9	.563	.419	.382	
	cp_knw6	.561	.472	.315	
	cp_knw8	.559	.385	.343	
	cp_knw3	.537	.314	.351	
	cp_knw1	.475	.445	.303	
	cp_knw5	.447	.399	.282	
Learning management	cp_mgm3	.328	.354	.686	.667
	cp_mgm2	.395	.169	.615	
	cp_mgm1	.506	.424	.525	
	cp_mgm9	.403	.408	.461	

Conclusion

Although cognitive presence is considered an important factor in e-Learning, there is no widely accepted scale to measure it. Through a literature review, we have derived three major constructs of cognitive presence. The proposed scale went through a validation process with 723 online learners in the course of two independent studies. Exploratory factor analysis confirmed that cognitive presence is composed of three dimensions: clear understanding, knowledge construction, and learning management.

Even after the effort of trying to increase the validity and reliability of the scale by refining and adding more items, the third construct, learning management, still showed relatively low at the follow-up study. This needs further investigation of the scale in respect to compose proper items for the construct. A subsequent study is in progress to conduct a CFA(confirmatory factor analysis). Furthermore, external validity of this scale should be checked with learning outcome variables such as achievement, participation, and satisfaction in e-Learning. This research begins to enlighten the insights on how to design an e-Learning environment to facilitate the engagement of the learners by using the cognitive presence scale as an indicator. Our ongoing studies are to integrate the cognitive presence with other two presence– social and emotive presence- and to comprehend the whole picture of e-Learning process as well as outcomes.

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