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Course-level implementation of First Principles, goal orientations, and cognitive engagement: a multilevel mediation model

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Abstract The First Principles of Instruction (FPI) represent ideologies found in most instructional design theories and models. Few attempts, however, have been made to empirically test the relationship of these FPI to instructional outcomes. This study addresses whether the degree to which FPI are implemented in courses makes a difference to student cognitive engagement, taking into account the mediating role of individual goals. A multilevel meditation model was tested with 1070 undergraduate students from 29 courses in a Korean university. Findings demonstrated that the influences of course-level implementation of FPI influence cognitive engagement through individual intrinsic goal orientation. Course-level implementation of FP does not directly affect surface strategy use and self-regulated strategy use; rather, the effect of FPI appears to be mediated by intrinsic goal orientations. Course-level implementation of FPI also appears to affect deep cognitive strategy use directly as well as indirectly through intrinsic goal orientation. The present study added novel evidence linking Merrill's First Principles of Instruction to cognitive engagement.

Keywords First Principles of Instruction · Cognitive engagement · Goal orientation · Multilevel mediation model

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Introduction

Cognitive engagement is defined as involving meaningful and thoughtful approaches to learning tasks (Paris and Paris 2001). The levels of cognitive engagement are often indicated by students' use of learning strategies such as cognitive strategies and metacognitive strategies. There has been a long debate over whether students' learning strategy uses are consistent or varying over time and across contexts. Empirical studies have shown that to some extent, cognitive engagement can be modified by individual or contextual differences (e.g., Eley 1992; Nijhuis et al. 2005; Wilson and Fowler 2005)—that is, different students use different learning strategies in the same academic work and the same students adopt different learning strategies in different academic contexts. Thus, identifying the factors that explain the variability of students' cognitive engagement has become a major research focus. Some have sought internal factors within students that explain variability in cognitive engagement such as students' goal orientations (e.g., Dupeyrat and Mariné 2005; Greene and Miller 1996; Lyke and Young 2006; Pintrich et al. 1994; Wolters 2004). Others have sought to explore factors within the learning environment focusing on how certain structures within a course can promote student learning engagement. These studies have specifically explored factors related to characteristics of tasks and learning activities (Kyndt et al. 2011; Pintrich et al. 1994), teachers' behaviors during instruction (Jang et al. 2010; Pintrich et al. 1994), classroom goal structures (Lyke and Young 2006; Wolters 2004), and the integration of student-oriented learning, action learning, problem-based learning, and constructivist learning (Nie and Lau 2010; Nijhuis et al. 2005; Rotgans and Schmidt 2011; Wilson and Fowler 2005).

When predicting cognitive engagement, most prior studies have examined either personal factors or classroom environmental factors; thus, separate links between personal factors and cognitive engagement (DeBacker and Crowson 2006; Dupeyrat and Mariné 2005; Greene and Miller 1996; Pintrich and De Groot 1990; Pintrich and Garcia 1991; Walker et al. 2006) or classroom environmental factors and cognitive engagement (Ahlfeldt et al. 2005; Jang et al. 2010; Nie and Lau 2010) have been established. In addition, many motivational studies highlight the links between students' goal orientations and the learning environment, arguing that students' adoption of goals is also context dependent (e.g., Church et al. 2001; Meece et al. 2003). Thus, there have been calls for research to examine both personal and environmental factors simultaneously (e.g., Ames 1992; Pintrich and Schrauben 1992; Pintrich et al. 2003). Taken the links among learning contexts, goal orientations, and cognitive engagement that have been separately established together, it is reasonable to hypothesize a mediating relationship; the learning environment exerts its indirect influence on cognitive engagement through motivational orientations.

In prior studies, various structures within the course promote student cognitive engagement have been explored in conjunction with a concern for the improvement of instruction. As a framework for the creation of engaging course structures, this study focuses on course-level integration of instructional design principles. Instructional design researchers point out that engaging instruction does not happen without careful application of instructional design principles which are proven to consistently facilitate effective, efficient, and engaged learning (e.g., Merrill 2002; Reigeluth and Carr-Chellman 2009). For example, Merrill (2008) claimed that "There are known instructional strategies. If an instructional experience or environment does not include the instructional strategies required for the acquisition of the desired knowledge and skills, then effective, efficient, and engaging learning of the desired outcome will not occur" (p. 267). According to Merrill, courses that integrate these strategies should promote student engagement. Therefore, when linking classroom environmental factors and student engagement, a focus of interest can be the relationship between the extent to which the instructional design principles are integrated into courses and cognitive engagement.

Cognitive engagement

Cognitive engagement has been used to describe the student learning process in regard to academic materials and instruction itself in classroom context (e.g., Corno and Mandinach 1983; Fredricks et al. 2004; Lyke and Young 2006). Underlying assumptions of cognitive engagement are that learning is a constructive process of students and that the process mediates between the characteristics of individuals and learning outcomes as well as between the characteristics of learning environment and learning outcomes (Pintrich 2004). As cognitive engagement means students' investment in deep learning of academic tasks (Zepke 2014), cognitive engagement has been conceptualized as a combination of students' use of cognitive strategies such as rehearsal, elaboration, organization, and critical thinking strategies, and metacognitive self-regulated strategies. Thus, it is assumed that successful students use both effective cognitive and metacognitive learning strategies (DeBacker and Crowson 2006; Greene and Miller 1996; Pintrich and De Groot 1990; Walker et al. 2006; Wolters 2004). In the literature, a surface level of engagement is often indicated by students' use of rote memorization and rehearsal strategies (Pintrich and Garcia 1991; Zusho and Pintrich 2003). A deep level of engagement is indicated by a combination of cognitive strategies such as elaboration, organization and critical thinking, and self-regulated learning strategies (Dupeyrat and Mariné 2005; Nie and Lau 2010). Research suggests that students who employ deeper levels of cognitive strategies and self-regulated strategies are likely to be more fully engaged with their learning than are students who employ surface levels of cognitive strategies (Pintrich and Garcia 1991; Pintrich and Schrauben 1992). Empirical studies have shown that the level of cognitive engagement is an important predictor of various learning outcomes such as standardized test scores (Nie and Lau 2010), grades (Wolters 2004; Wolters and Pintrich 1998), and task and assignment scores (Pintrich and De Groot 1990).

There has been a long debate over whether students' learning strategy uses are consistent or varying over time and across contexts (e.g., Eley 1992; Nijhuis et al. 2005; Wilson and Fowler 2005; Vermetten et al. 2002). Empirical studies have shown that the cognitive engagement can be, at least in part, modified by individual or contextual difference (e.g., Greene and Miller 1996; Jang et al. 2010). Therefore, researchers are interested in identifying the factors that lead to students' deeper levels of engagement. Some researchers have focused on individual factors such as goal orientations and shown a consistent, positive relationship between individual learning- and mastery-oriented goals and deeper levels of engagement, whereas performance-oriented goals predict surface or shallow levels of engagement among university students (Dupeyrat and Mariné 2005; Greene and Miller 1996; Lyke and Young 2006; Walker et al. 2006). Some other researchers have attempted to understand how certain practices within the course promote student learning engagement in conjunction with a concern for the improvement of instruction such as task characteristics (Pintrich et al. 1994), classroom goal structures (Lyke and Young 2006; Wolters 2004), and autonomy orientations (Jang et al. 2010). Still, other researchers have explored the effects of redesigned courses that integrate student-oriented learning, action learning, problem-based learning, and constructivist learning (Ahlfeldt et al. 2005; Meece et al. 1988; Nie and Lau 2010; Nijhuis et al. 2005; Rotgans and Schmidt 2011; Wilson and Fowler 2005). However, it seems the literature has been inconclusive: These instructional design approaches to prompt deep levels of cognitive engagement are not always as successful as hoped (Nijhuis et al. 2005; Rotgans and Schmidt 2011; Wilson and Fowler 2005). Researchers argue that the inconclusive nature of this research may be a result of weakly implemented designs in the studied learning environments that may not have been rigorous enough to prompt changes in student engagement (e.g., Nijhuis et al. 2008). Thus, this study suggests Merrill's First Principles of Instruction as a framework for designing engaging instruction.

First Principles of Instruction

Merrill (2002, 2009) identified fundamental principles that are included in most instructional design theories and models and that are necessary for designing effective, efficient, and engaging instruction. In 2002, Merrill first proposed a set of fundamental principles of instructional design called First Principles of Instruction. These First Principles were based on existing instructional design theories and models, most of which prescribed different approaches to instructional design yet were based on the same underlying principles.

First Principles of Instruction (Merrill 2009) suggested that learning is promoted (1) when learners are engaged in task-centered, real-world problems; (2) when existing knowledge is activated as a foundation for new knowledge; (3) when new knowledge is demonstrated to the learner; (4) when new knowledge is applied by the learner; and (5) new knowledge is integrated into the learner's context.

Merrill argued that these principles can be implemented in a variety of ways by different practices of instruction, and the extent to which the principles are implemented in a course determines effectiveness, efficiency, and student engagement. That is, if a course does not adequately incorporate these instructional principles, it may cause learning problems in students' acquisition of knowledge or skills, or their engagement in learning (Merrill 2008; van Merriënboer et al. 2002). Merrill suggests that research should be conducted to validate these principles in various teaching and learning contexts.

Despite the theoretical and practical importance of the First Principles in designing instruction, little attempt has been made to empirically validate the association between the principles and various instructional outcomes. Previous empirical works have linked the First Principles to overall quality of instruction in online course contexts (Cropper et al. 2009; Margaryan et al. 2015), students' levels of remembering, understanding, and problem-solving in undergraduate biology courses (Gardner 2011), quality of instruction, students' satisfaction with courses, and academic learning time in university courses (Frick et al. 2009, 2010), problem-solving ability, and learning satisfaction (Kim and Jung 2013). For example, Frick and his colleagues conducted a series of studies to link the First Principles of Instruction and university course quality (2009, 2010). Overall, in courses where students indicated that instructors integrated more First Principles into the course, higher levels of student satisfaction, course quality, perceived learning gain, and mastery of course objectives were reported. The degree to which First Principles were integrated in the courses was also positively related to students' reported amounts of learning time and effort.

Although empirical evidence shows that the principles contributed to effective and engaging instructional design and, ultimately, improved student learning, more evidence is needed to support the validity of the First Principles of Instruction. The current study focuses on student engagement in learning as a desired outcome of the integration of the principles.

Method

Design of the study

The purpose of this study was to explore the relationship between course-level implementation of the First Principles of Instruction and students' cognitive engagement, taking into account the role of individual goals in this relationship. As both individual goals and learning environment were found to be related to students' engagement, researchers suggest testing a causal mechanism by which the effects of learning environment operate through students' goal orientations (e.g., Pintrich et al. 2003).

This study investigates whether course-level instructional design practices influence student engagement through individual goal orientations in multiple courses. Therefore, the study employs multilevel modeling approach. The multilevel modeling method is an appropriate analytical technique when multiple courses are involved in the study, and students were nested within courses (Raudenbush and Bryk 2002). It allows for partitioning the proportion of variance on cognitive engagement at the student and course level and for examining hierarchical relationships that course-level predictors influence student-level outcomes. Thus, a multilevel mediation model was explored. Figure 1 depicts the mediation model.

In 1986 Baron and Kenny first introduced the analytical technique for testing mediation that is now the most commonly used for single-level mediational analysis. The procedure of mediational analysis involves three tests: first, the outcome variable is regressed on the predictor; second, the mediator is regressed on the predictor; and third, the outcome variable is regressed on both the mediator and the predictor. In order to establish mediation, the relationships between the outcome and the predictor, between the mediator and the predictor, and between the mediator and the outcome must be significant. Baron and Kenny's procedures have been reformulated in multilevel settings as follows (e.g., Krull and MacKinnon 2001; Zhang et al. 2009).

$$\begin{aligned} &\text{Level 1}: Y_{ij} = \beta_{0j} + r_{ij} \\ &\text{Level 2}: \beta_{0j} = \gamma_{00} + \gamma_c X_j + u_{0j} \end{aligned} \quad (1)$$

$$\begin{aligned} &\text{Level 1}: M_{ij} = \beta_{0j} + r_{ij} \\ &\text{Level 2}: \beta_{0j} = \gamma_{00} + \gamma_a X_j + u_{0j} \end{aligned} \quad (2)$$

$$\begin{aligned} &\text{Level 1}: Y_{ij} = \beta_{0j} + \beta_b M_{ij} + r_{ij} \\ &\text{Level 2}: \beta_{0j} = \gamma_{00} + \gamma_{c'} X_j + u_{0j} \end{aligned} \quad (3)$$

According to the procedure, the first step in testing the 2–1–1 mediation effect is to establish a relationship between the level 2 predictor (class-level FP) and the level 1 outcome (cognitive engagement). The second step is to establish a relationship between the level 2 predictor (class-level FP) and the level 1 mediator (individual goal orientation). The final step is to show the effect of the level 2 predictor (class-level FP) on the level 1 outcome (cognitive engagement) after adding the level 1 mediator (individual goal orientation).

Participants

This study used the stratified sampling, a type of probability sampling to consider academic disciplines. One thousand and seventy (1070) undergraduate students from twenty-nine courses from six academic majors in a large Korean university participated in this survey research. The courses included: six courses from the Language Department (e.g., Practical English grammar, Practical Japanese grammar); four courses from the Business and Economics Department (e.g., Theory of futures and options, Taxation); six courses from the Social Science Department (e.g., Organization development methodologies, International relations); three courses from the Natural Science Department (e.g., General physics, Human physiology); five courses from the Engineering Department (e.g., Artificial intelligence programming, Encryption of information); and five courses from Education Department (e.g., Introduction to education, Sociology of education). In this study, the academic major to which the courses belong was considered as a course property used to examine whether the relationship between the implementation of the First Principles and students' cognitive engagement differ among varying academic majors. With regard to academic majors, 17.1 % ($n = 183$) of the participants took courses in the Language Department, 16.9 % ($n = 181$) took courses in Business and Economics, 29.1 % ($n = 311$) took courses in Social Science, 9.3 % ($n = 99$) took courses of in Natural Science, 14.8 % ($n = 158$) took courses in Engineering, and 12.9 % ($n = 138$) took courses in Education.

Male students represented 37.7 % ($n = 400$) of the sample, while female students represented 62.3 % ($n = 660$) of the total participants. Ten students did not indicate their gender. With regard to academic rank, 5.2 % ($n = 56$) of the participants were freshmen, 32.4 % ($n = 346$) were sophomores, 34.1 ($n = 364$) were juniors, and 28.3 % ($n = 303$) were seniors.

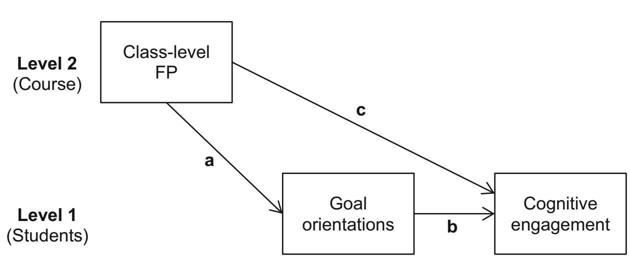

Fig. 1 Hypothesized multilevel mediation model

Measures

Levels of cognitive engagement

Cognitive strategy use was measured by the recent version of Motivated Strategies for Learning Questionnaire (MSLQ), which was developed by Pintrich et al. (1991). The cognitive and self-regulatory strategy scales of the MSLQ have been used separately or in combination in the literature. Empirical investigations have shown many different factor structures of cognitive and self-regulatory strategy or of surface and deep levels of engagement. This study conceptualized a three-factor structure: surface cognitive strategy use measured by the items of rehearsal strategy; deep cognitive strategy use measured by the items of elaboration strategies, organizational strategies, and critical thinking strategies; and self-regulated strategies use measured by the items of metacognitive self-regulated strategies. The items use a seven-point Likert scale from "not at all true of me" to "very true of me." The goodness-of-fit statistics of a confirmatory factor analysis indicated that the three-factor structure was acceptable with

RMSEA = 0.07, CFI = 0.91, and TLI = 0.90, with the exception of the Chi-square value, which was significant $\chi^2 = 821.21$ ($df = 130$, $p < .001$). However, this might be expected with a larger sample size ($n = 1070$), since Chi-square fit statistics are known to be affected by sample size (Klein 2005). Cronbach's alphas of the items for surface cognitive strategy use, deep cognitive strategy use, and self-regulated strategies use were .640, .880, and .817, respectively.

Students' goal orientations

Intrinsic and extrinsic goal orientation scales were also measured with four items each adopted from the MSLQ. Cronbach's alphas of the items for intrinsic goal orientation and extrinsic goal orientation were .734 and .733, respectively.

First Principles of Instruction

The degrees to which Merrill's First Principles of Instruction were incorporated into the course were measured by the items taken from Teaching and Learning Quality (TALQ) instrument developed by Frick et al. (2008). TALQ includes 20 items that measure students' perceptions of the implementation of Merrill's five principles: authentic problems (four items), activation (four items), demonstration (five items), application (three items), and integration (four items). Factor analysis extracted a single-factor structure with eigenvalues greater than 1.0 for the First Principle items. All items of the First Principle measure strongly load on the same factor. This means that although the First Principle measure consists of five instructional design principles such as activation, demonstration, application, integration, and task-centered, students perceive them as overall course context. The results were consistent with EFA results conducted by Frick et al. (2010). Cronbach's alpha was .917. The score of the First Principles measure aggregated to the class level (class-level FP).

As in many other studies (Lyke and Young 2006; Nie and Lau 2010; Nijhuis et al. 2007; Pintrich et al. 1994; Wolters 2004), this study relied on students' perception data as a measure of learning environment. Theoretical and empirical evidence suggests that students' perception is a valid measure when studying the effects of learning environment design because a learning environment does not directly influence students' learning; rather, it indirectly affects the ways students perceive their learning environment (Ames 1992; Koszalka et al. 2002). Thus, this study used the aggregated students' perceptions of the implementation of the First Principles at the course level as a measure of learning context variable.

Procedures

The researcher scheduled a time to visit each course to administer the survey instrument. Two separate packets were prepared for students: the consent form and the survey instrument. The survey instrument was combined into one anonymous paper and pencil survey including students' background information. No personal identification information was included in the survey instrument.

Students were informed that they were invited to participate in the study, but that participation was voluntary, anonymous, and would not affect any course outcome. Students were further informed that no personal data related to their identification would be collected, and they could skip any questions or stop at any time if they felt uncomfortable, when answering the questions. The researcher gave each student a copy of the consent form before administering the survey. After the consent forms were collected, the survey instrument was administered. While the survey was being administered, the researcher was out of the classroom. Students were guided to submit the survey on the desk in front of the classroom when they had finished; then, they could leave the class. A set of consent forms and survey instruments were put into each envelope, and course information was marked. The instructors and TA's were not allowed to access the survey instrument or see individual data.

Results

Data from 1070 undergraduate students from 29 courses were analyzed. Means, standard deviations, and zero-order correlations for the variables used in the study are presented in Table 1.

Students' perceptions of the First Principles were positively related to all scales of cognitive engagement and intrinsic motivation. The perception of the First Principles was strongly correlated with deep cognitive strategy use ($r = .624$, $p < .01$); moderately correlated with self-regulated learning ($r = .492$, $p < .01$); and weakly correlated with surface level engagement ($r = .286$, $p < .01$). Students' perception of the First Principles was not significantly correlated with extrinsic goal orientation ($r = .049$, $p > .05$), while they were significantly correlated with intrinsic goal orientation ($r = .453$, $p < .01$). The scales of surface engagement, deep engagement, and self-regulated learning were correlated to each other.

Multilevel mediation model

According to the procedure outlined in the previous section, a relationship between class-level FP (level 2

Table 1 Means, SD, and zero-order correlations among observed variables

	Mean	SD	FP	Surface	Deep	Self-regulated	Intrinsic	Extrinsic
FP	3.483	0.576	1					
Surface	4.888	1.145	.286**	1				
Deep	4.513	0.898	.624**	.496**	1			
Self-regulated	4.558	0.911	.492**	.580**	.786**	1		
Intrinsic	4.581	1.139	.453**	.249**	.625**	.535**	1	
Extrinsic	5.544	1.014	.049	.305**	.194**	.271**	.023	1

** $p < 0.01$; * $p < 0.05$

predictor) and cognitive engagement (level 1 outcome) was first established. See Table 2 for those findings.

A significant relationship was found between class-level FP and deep cognitive strategy use and between class-level FP [$\beta = .905$, $t(27) = 140.321$, $p < .001$] and self-regulatory strategy use [$\beta = .417$, $t(27) = 121.353$, $p < .001$]. However, there was no significant relationship between class-level FP and surface strategy use [$\beta = .111$, $t(27) = .498$, $p < .05$]. According to Baron and Kenny (1986), this nonsignificant relationship between class-level FP and surface level of engagement implies that there is no effect to mediate; thus, an indirect effect would not exist. However, Rucker et al. (2011) suggest that the predictor exerts a stronger influence on the mediator than on the outcome, which could lead to a significant indirect effect even when the effect of the predictor on the outcome is not significant. Therefore, we began further analysis for surface level of engagement.

Second, a relationship between class-level FP (level 2 predictor) and individual goal orientation (level 1 mediator) was established. See Table 3 for those findings.

There was a significant effect of class-level FP on students' intrinsic goal orientation [$\beta = .970$, $t(27) = 4.462$, $p < .001$], but not for extrinsic goal orientation [$\beta = -.216$, $t(27) = -1.440$, $p > .05$]. Since the significant relationship between class-level FP and extrinsic goal orientation did not exist, further analysis was not justified. It implies that extrinsic goal orientation is not a mediator of the relationship between class-level FP and cognitive engagement.

Table 3 Multilevel analysis with level 2 predictor and level 1 mediator

	Intrinsic		Extrinsic	
	Coefficient	SE	Coefficient	SE
Intercept	4.650***	0.050	5.512***	0.040
Class level				
Mean_FP	0.970***	0.217	−0.216	0.150
Variance				
γ	1.189		1.003	
$u0$	0.037***		0.023**	

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

The final step in this analysis was to show the effect of class-level FP (level 2 predictor) on cognitive engagement (level 1 outcome) after adding students' goal orientation (level 1 mediator). See Table 4 for those findings.

There was no previously significant effect of class-level FP on students' use of surface cognitive strategies, but the results indicated that class-level FP increases intrinsic goal orientation (.970, $p < .001$), which in turn increases surface cognitive strategy use (.261, $p < .001$).

The addition of goal orientation led to a significant reduction in the relationship between class-level FP and

Table 2 Multilevel analysis with class-level FP

	Surface		Deep		Self-regulated	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Intercept	4.852***	0.067	4.565***	0.033	4.568***	0.038
Class level						
Mean_FP	0.111	0.222	0.905***	0.135	0.417**	0.038
Variance						
γ	1.234		0.733		0.799	
$u0$	0.097***		0.012*		0.019**	

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Table 4 Multilevel analysis with level 2 predictor, level 1 mediator and level 1 outcome

	Surface		Deep		Self-regulated	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Intercept	4.844***	0.065	4.541***	0.024	4.541***	0.035
Student level						
Intrinsic	0.261***	0.035	0.459***	0.024	0.426***	0.026
Extrinsic	0.315***	0.022	0.166***	0.021	0.219***	0.019
Class level						
Mean_FP	−0.093	0.225	0.465***	0.102	0.037	0.134
Variance						
γ	1.051		0.446		0.523	
$u0$	0.094***		0.006*		0.023***	

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

deep cognitive strategy use (from beta coefficient of .905–.465); therefore, intrinsic goal orientation is a partial mediator because the class-level FP coefficient decreased after the effects of goal orientation was partial out but is still significant. Thus, it is suggested that class-level FP directly increase students' deep cognitive strategy use as well as their intrinsic goal orientation; further, the increased intrinsic goal orientation, in turn, affects increased levels of deep cognitive strategy use.

The addition of goal orientation also made the relationship between class-level FP and self-regulated strategies no longer significant (from .417 to .037). Therefore, in this relationship intrinsic goal orientation would be considered a complete mediator—that is, overall significant relationship between class-level FP and self-regulated strategy use was due to the effect of class FP on intrinsic goal orientation. Class-level FP increases intrinsic goal orientation, which in turn affects increased levels of self-regulated strategy use.

Considering the results together, the following path model presents the relationships among course-level implementation of First Principles, goal orientations, and cognitive engagement outcomes. See Fig. 2.

Overall, it appears from these findings that class-level implementation of the First Principles does not directly affect surface strategy use and self-regulated strategy use. Rather, the effect of the First Principles appears to be mediated by intrinsic goal orientations. That is, if a course implements more instructional design principles such as activation, demonstration, application, integration, and task-centered principles, then students are likely to focus on mastery and learning of course materials. As a result of students' endorsement of mastery and learning goals, they tend to report more use of surface strategies and self-regulated strategies.

As for deep strategy use, class-level implementation of the First Principles appears to have affected deep cognitive strategy use both directly and indirectly through intrinsic goal orientation. This suggests that as a course integrates more First Principles, students are likely to engage in the course with the purpose of mastering the course materials. This in turn may encourage students to use more deep cognitive strategies such as elaboration, organization, and critical thinking.

Discussion and implications

The present study extends previous work on learning environment design associated with student learning engagement by adding new data linking Merrill's First Principles of Instruction to cognitive engagement. The results of this study clearly show that the degree to which the First Principles are implemented in courses may account for the variance in deep strategy use and self-regulated strategy use, but not for the variance in surface strategy use. That is, greater implementation of the First Principles in courses significantly increases students' use of deep cognitive strategies such as elaboration, organization, and critical thinking strategy and self-regulated strategies, but does not significantly increase the use of surface strategies.

The study provides further support for the mediating role of goals in the relationship between learning environmental factors and cognitive engagement. The findings of the present study clearly demonstrate that the influences of course-level implementation of FPI influence cognitive engagement through individual intrinsic goal orientation. The implementation of FPI was initially found to be a significant predictor of deep cognitive strategy use and self-regulated strategy use. However, the addition of goal orientation variables changed the relationships. A direct relationship between FPI and deep cognitive strategy use was substantially reduced, and a direct relationship

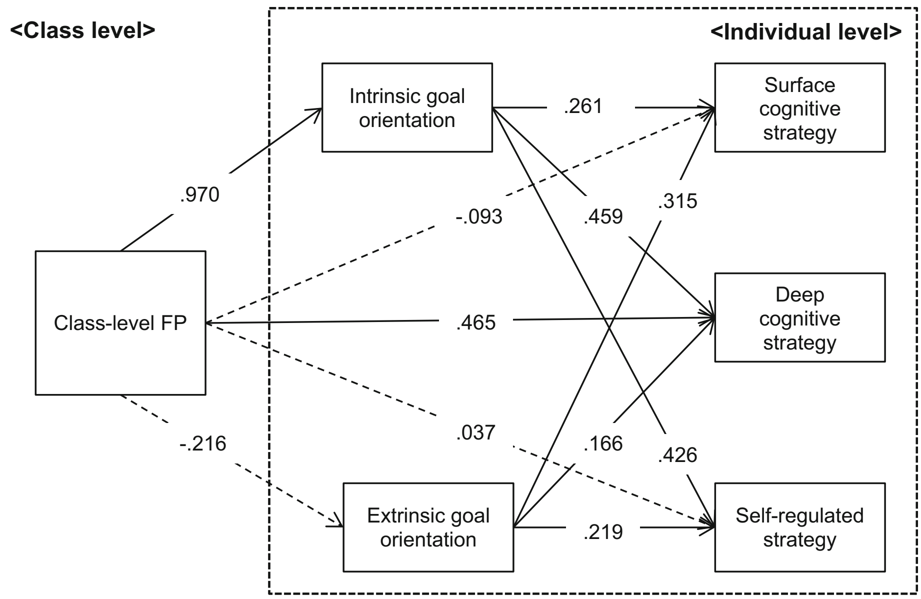

Fig. 2 Class-level FP to cognitive engagement mediation model. *Note*: *Solid lines* represent significant paths; *dotted lines* represent nonsignificant paths at $p < .05$

between FPI and self-regulated strategy use was no longer significant with the presence of goal orientations. Instead, intrinsic goal orientation mediated the effects of FPI. The implementation of FPI was only indirectly linked to surface strategy use and self-regulated strategy. Thus, it could be argued that intrinsic goal orientation is a necessary condition to convey the effects of FPI to surface and self-regulated strategy use. In previous empirical studies, this causal mechanism by which course context affects cognitive engagement has been less known; thus, this finding allows a better understanding of the complexity of the processes of learning.

This study also extends earlier work on the role of context in students' adoption of goal orientations. The present study found that the implementation of FPI also influences students' personally endorsed goals. In courses rated higher on the implementation of the principles, students seem to have higher level of intrinsic goal orientations. Extrinsic goal orientations were not influenced by the principles. While much of interest in classroom learning environment has focused on getting students to adopt mastery and learning goal orientations (e.g., Ames 1992; Pintrich and Schrauben 1992; Pintrich et al. 2003), little attention has been paid to course design that influences the outcome. Extending prior studies, the current study clearly identified a set of instructional principles with respect to how a course should be designed to enhance students' adoption of intrinsic goal orientations.

This study also provides a test of the empirical distinction between the cognitive engagement indicators. Findings indicated that the indicators of cognitive engagement appear to act independently, showing that each is differently associated with learning environmental factors and goal orientations. The strengths of the relationships vary according to each cognitive engagement outcome, and the causal mechanisms among the implementation of FPI, goal orientations, and cognitive engagement outcomes also vary. Cognitive engagement has typically been operationalized by four scales of basic cognitive strategies (rehearsal, elaboration, organization, and critical thinking strategies) and a single scale of self-regulated strategy in the literature (Pintrich 2004). The scales have been used separately or in combination based on a distinction between surface and deep levels of engagement. Surface level engagement was typically indicated by the rehearsal or memorization strategy use; however, many different combinations of cognitive strategies and self-regulated strategies were used to indicate deeper levels of engagement. Empirical investigation also shows many different factor structures; some separate cognitive strategy and self-regulated strategy (e.g., Pintrich and De Groot 1990); and some others combine deep cognitive strategy and self-regulated strategy as a single indicator of deep levels of engagement in learning (e.g., DeBacker and Crowson 2006; Greene and Miller 1996; Walker et al. 2006). Based on the theoretical and empirical evidence, the current study separates surface cognitive strategy use indicated by score of rehearsal strategies, deep cognitive strategy use indicated by composite score of elaboration, organizational and critical thinking strategies to indicate a deep level of engagement, and self-regulated strategy use indicated by score of self-regulated strategies. Consequently, the findings help to clarify the conceptualization of cognitive engagement by suggesting the need to distinguish surface, deep, and self-regulated strategies rather than combine surface and deep cognitive strategies or deep cognitive strategies and self-regulated strategies as a single construct. This distinction allows a clearer explanation of the relationships among the implementation of the First Principles of Instruction, goal orientations, and cognitive engagement.

When studying course context, it is important to account for the social nature of data Pintrich et al. (2003). That is, instructional practices are inherent in a course or an instructor; thus, the differences in the characteristics of the course or the instructor may influence a specific learning outcome. However, despite the obvious social nature of the data involved in most learning environment studies, little study has focused on the course-level effects on student learning outcomes. The majority of existing research linking learning environment and cognitive engagement has ignored the course-level effects (e.g., Ahlfeldt et al. 2005; Meece et al. 1988; Nijhuis et al. 2005; Rotgans and Schmidt 2011; Wilson and Fowler 2005). In this study, it was clearly evident that there were course-level effects on cognitive engagement as well as student-level effects. This means that the common characteristics of a course in terms of the implementation of FPI have some influence on students' levels of cognitive engagement. When students were in the course that integrated more FPI, they were likely to engage at deeper levels. Overall, 6.6 % of the variance in students' deep cognitive strategy use was explained by between-course differences in the implementation of FPI. Hox (1995) noted that analysis of variance may overestimate the effects of student-level predictors if course effects are not taken into account.

Limitations of study

The fact that this study did not examine a possible link between cognitive engagement and any achievement measure is a limitation of this study, although the study is grounded in empirical evidence that cognitive engagement is positively related to various learning outcomes such as standardized test scores (Nie and Lau 2010), grades (Wolters 2004; Wolters and Pintrich 1998), and task and assignment scores (Pintrich and De Groot 1990). In order to provide a more persuasive and meaningful argument for researchers and practitioners in higher education, the sophisticated relationships between cognitive engagement outcomes and various learning outcomes should be further investigated.

Also, the study included a limited set of variables related to student engagement. The multilevel model, taking into account students' goal orientations and course-level FPI in Table 4, explains 13.7 % of total variance in surface strategy use, 43.9 % in deep strategy use, and 45.5 % in self-regulated strategy use. There are still variances remaining in each cognitive outcome, which is the portion of the outcome variance that is not accounted for by the variables of interest in this study. This implies that more research on other variables is needed to reveal the complexity of students' cognitive engagement. Prior research suggested that task value (Pintrich et al. 1994), self-efficacy (Meece et al. 1988, 2003), and prior achievement (Wolters 2004) may make important contributions to cognitive engagement. These variables could also act as mediators, although this study tested only one causal mechanism with students' goal orientations.

Although the academic major to which the courses belong could be take into account as a level 3 variable, this study focused only on two-level model including student- and course-level variables. It was because the main purpose of this study is to examine whether there are significant variances in students' cognitive engagement across university courses and whether the variances are related to the course-level implementation of First Principles. However, another study could be designed to test three-level model including the academic majors. This type of study would increase the understanding of students' cognitive engagement at student, course, and academic major level.

As in many other studies of learning environments (Lyke and Young 2006; Nie and Lau 2010; Nijhuis et al. 2007; Pintrich et al. 1994; Trigwell and Prosser 1991; Wolters 2004), this study relied on students' perception data as a measure. Although theoretical and empirical evidence suggests that students' perception of learning environment is a valid measure (e.g., Ames 1992; Koszalka et al. 2002), the use of multiple sources of data such as observation data or instructor's ratings would have provided the researcher with additional validating information on the extent to which student perceptions reflect actual features of the classroom environment (Church et al. 2001).

Conclusion

This study attempted to verify Merrill's claim that the extent to which the First Principles of Instruction are implemented in a course determines effectiveness, efficiency, and student engagement. Despite the theoretical and practical importance of the First Principles of Instruction, few attempts have been made to empirically test the relationships of the principles with instructional outcomes. By focusing on cognitive engagement as an outcome of instruction that implements First Principles, this study attempted to answer the question of whether the degree to which the First Principles of Instruction are implemented in courses indeed makes a difference in student cognitive engagement when taking into account the mediating role of individual goals.

Findings demonstrated that the influences of course-level implementation of the First Principles of Instruction influence cognitive engagement through individual intrinsic goal orientation. Course-level implementation of the First Principles of Instruction does not directly affect surface strategy use and self-regulated strategy use; rather, the effect of the First Principles of Instruction appears to be mediated by intrinsic goal orientations. Course-level implementation of the First Principles of Instruction also appears to affect deep cognitive strategy use directly as well as indirectly through intrinsic goal orientation.

The current study identified the First Principles of Instruction as an effective framework for designing engaging instruction as Merrill claims. Instructional design practices that integrate Merrill's First Principles of Instruction are more likely to help students endorse intrinsic goal orientation and use more cognitive strategies and self-regulated strategies. The results give instructional designers or university instructors a better idea of how a course should be structured and improved in a way to engage more students in the course.

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