

Impact of learning styles on learning-skill development in higher education

Yoshitaka Yamazaki
Graduate School of International Management
International University of Japan

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Yamazaki, Yoshitaka

Graduate School of International Management, International University of Japan
777 Kokusai, Minami Uonuma, Niigata 949-7277, Japan

E-mail address: yyama@iuj.ac.jp

Tel number: 81-25-779-1106

Fax number: 81-25-779-1187

Abstract

The aim of this study was to examine how learning styles impact the development of 12 learning skills in higher education by using Kolb's learning theory. The results revealed that two learning abilities in the dialectical dimension of concrete experience and abstract conceptualization significantly affected development in three interpersonal and three analytical skills. However, two learning abilities in the other dialectical dimension of reflective observation and active experimentation had a marginal influence on related skill development. Further, more balanced learning styles of the freshmen sample hindered the development of three analytical skills and one perceptual skill. In conclusion, university students should learn by specializing in learning abilities to develop their concomitant learning skills except for three perceptual skills. Additionally, students should avoid learning by balancing two dialectical learning abilities, especially concrete experience and abstract conceptualization in order to develop analytical skills in higher education.

Keywords

Learning styles; learning-skill development; Kolb's learning theory; higher education

1. Introduction

For three decades learning styles have attracted much attention from educators and researchers as a way of describing individual differences in learning (Desmedt & Valcke, 2004). The term “learning style” applied in this manner is thought to contain constructs that illustrate an approach to individual learning (Price, 2004). A significant amount of academic as well as practitioner-based research on learning styles has been conducted (Cassidy, 2004) in a wide range of social and medical science fields such as education, management, computer science, medicine, nursing, psychology, accountancy, and law (Kolb & Kolb, 2010).

There is a general understanding in the study of learning style that individuals’ learning style preferences affect their performance and achievement (Cassidy, 2004). A relatively recent study by Demirbas and Demirkan (2007) of the academic context of design education shows the impact of learning styles on academic performance. Although there exist some learning theories that explain the relationship between learning styles and skills such as Curry’s (1987) three-layer “onion” model and Kolb’s (1984) experiential learning theory, there has been little empirical research since the 1970s on how learning styles affect skill development in higher education. A few empirical studies have actually been conducted on the relationship between learning styles and skills. The main purposes of these studies have examined several different areas, such as the association between learning styles, adaptive flexibility, and four competency areas in business schools (Mainemelis, Boyatzis, & Kolb, 2002) and the connection between learning styles and interviewing skills in medical schools (Davies, Rutledge, & Davies, 1997). Another study was conducted to test a scale of learning skills in relation to learning styles (Boyatzis & Kolb, 1991); this third study described a relationship between learning styles and learning skills, but it did not show how learning

styles influence skill development. Thus, the question arises of which learning styles develop which certain skills in a set that consists of various skills to cope with tasks. For instance, does the development of relationship skills depend on a particular learning style? Is there a certain learning ability that affects the development of initiative skills? No one has yet investigated these questions. Examining how learning styles impact the development of a variety of skills in higher education would therefore be valuable. The present study focuses on this issue.

Among prevailing learning style models, Kolb's (1984) experiential learning theory was chosen for this study. It is one of the most influential theories (Duff, 2004), especially with regards to management development (Reynolds, 1997), management learning (Vince, 1998; Kayes, 2002), business education (Duff & Duff, 2002), business school and community (Yuen & Lee, 1994), and cross-cultural learning (Yamazaki & Kayes, 2004; Yamazaki, 2005). Jarvinen (1998) points out that Kolb's experiential learning theory has been largely employed not only in the field of adult education but also in that of education in general. More than 2,700 studies have examined and cited his learning model (Kolb & Kolb, 2010). Consistent with this number, the citation analysis made by Desmedt and Valcke (2004) concludes that Kolb is the most cited author in the literature of learning styles. It would be reasonable to apply Kolb's learning model for this study.

2. Experiential learning theory

2.1. Specialization of learning abilities

Individuals are required to develop specialized abilities and preferences for their learning (Kolb, 1984). These specialized abilities and preferences are called learning style. Learning styles tend to preserve individual uniformity in memory, perception, and thinking for various stimuli (Curry, 2000). Kolb's (1984) learning model encompasses not only individual cognitive mechanisms but also affective and behavioral functions; and it therefore

can be linked with the totality of human activities (Yamazaki, 2005). Learning styles are composed of four key components as learning abilities: concrete experience (CE), abstract conceptualization (AC), reflective observation (RO), and active experimentation (AE).

The CE ability involves grasping immediate experience through sensing and feelings, producing tacit knowledge (Kolb, 1984; Kolb, Boyatzis, & Mainemelis, 2001; Kolb & Kolb, 2005). In contrast, the AC ability, which is a dialectical relationship with the CE ability, entails generating concepts and ideas as explicit knowledge through logical thinking and analytical reasoning. Although the CE and AC abilities work to create two different types of knowledge, the RO and the AE abilities play an important role in transforming one type of knowledge into the other.

The RO abilities require reflecting on immediate experience in the form of tacit knowledge by observing it from various perspectives within the self. The focus of RO is on an introspective approach to transform tacit knowledge into explicit knowledge by figuring out the meaning of such experience. In contrast, the AE abilities, which are dialectically opposite to the RO abilities, necessitate taking action to test explicit knowledge generated by the AC abilities. This action then leads to an individual's new experience as a source of tacit knowledge created by the CE abilities. The AE abilities thereby serve to transform explicit knowledge into tacit knowledge through individual action.

A person tends to initially develop specialization of two learning abilities: one represents the CE or the AC ability in the AC versus CE dialectical learning dimension, whereas the other describes the RO or the AE ability in the AE versus RO learning dimension (Kolb, 1984; Mainemelis, et al., 2002). Consequently, various combinations among the four key learning abilities within one of these two dialectical dimensions makes four basic learning styles (Kolb, 1984; Kolb & Fry, 1975; Kolb, et al., 2001; Kolb & Kolb, 2005). The diverging learning style specializes in the two learning abilities of CE and RO. The

assimilating learning style emphasizes AC and RO abilities. The converging learning style develops into specialization of AC and AE abilities. Finally, the accommodating learning style accentuates specialization in CE and AE abilities. Figure 1 is described as Kolb's learning model.

Insert Figure 1 about here

2.2. Learning skills

Kolb's (1984) learning model also proposes 12 learning skills theorized in relation to learning styles (Mainemelis et al., 2002; Kolb & Kolb, 2005). Learning styles, which involve four learning abilities as discussed previously, are characterized as being generic adaptive competencies for learning environments, whereas learning skills refer to more situational, specific competencies required to deal with a variety of tasks (Kolb, 1984; Boyatzis & Kolb, 1991, 1995). These two properties indicate that the completion of a task that appears in a more proximate context of individual calls for use of a specific skill that is obtained by means of learning abilities. Individual learning styles entail the development of a particular skill in response to environmental demands. Boyatzis and Kolb (1991) argue that the relationship between learning styles and learning skills may be conceptually analogous with the one in Curry's (1987) three-layer "onion" model.

The classification of 12 learning skills is in accordance with learning style descriptions illustrated in Kolb's learning model (Boyatzis & Kolb, 1991, 1995). The CE ability of learning relates to the development of interpersonal skills such as leadership, relationship, and helping (Kolb, 1984; Boyatzis & Kolb, 1995; Rainey, Hekelman, Galazka, & Kolb, 1993). The RO ability affects the development of perceptual skills such as sense making, information gathering, and information analysis. The AC ability affects the development of analytical skills such as theory building, quantitative analysis, and technology.

Finally, the AE ability influences the development of behavioral skills such as goal setting, action, and initiative. Figure 2 illustrates the relationship between the four learning abilities and the learning skill taxonomy that is composed of the 12 learning skills.

Insert Figure 2 about here

2.3. Hypotheses

Individuals are thought to develop specialization in one of two learning abilities, staying in one dialectical learning dimension. Further, there is a theoretical relationship between the four learning abilities and the 12 areas of skill development in Kolb's learning model. Accordingly, the following four hypotheses about the specialization of learning abilities were created.

Hypothesis 1: If individuals are more specialized in CE versus AC learning ability, they will show a greater level of development in leadership skills, relationship skills, and helping skills.

Hypothesis 2: If individuals are more specialized in AC versus CE learning ability, they will show a greater level of development in theory-building skills, quantitative-analysis skills, and technology skills.

Hypothesis 3: If individuals are more specialized in RO versus AE learning ability, they will show a greater level of development in sense-making skills, information-gathering skills, and information-analysis skills.

Hypothesis 4: If individuals are more specialized in AE versus RO learning ability, they will show a greater level of development in goal-setting skills, action skills, and initiative skills.

2.4. Integration of learning abilities

Kolb's learning theory includes another unique feature of an individual way of

learning in which specialized learning abilities are integrated into a balanced learning style. Learning styles remain relatively stable in learning situations where individuals perceive, interact with, and react to their surroundings (Keefe, 1979). However, learning styles that specialize in two dialectical learning abilities may change in accordance with the stage of individual development; undeveloped learning abilities may be enhanced throughout of the course of an individual's life and career (Kolb, 1984).

When a person continually encounters unfamiliar and challenging learning situations, his or her initial learning style tends to adaptively change by developing the undeveloped learning abilities demanded from the challenging environment. For example, if a person with the diverging learning style, which emphasizes the CE (feeling) and the RO (reflecting) abilities, is newly situated in a learning and developmental environment that requires the AC (thinking) ability, this person is believed to begin to adaptively develop the AC ability. As a consequence, he or she would then specialize in the AC abilities in addition to the initially developed CE and RO learning abilities. Because there is a dialectical relationship between the CE and the AC abilities, this person must balance the two, rather than be inclined to either the CE or the AC ability. This person would then possess a balanced learning style that describes the integrated learning orientation rather than specialized learning.

According to Kolb's (1984) learning theory of individual development, this integrated learning direction may occur at a later time in the three developmental stages. The first stage of acquisition takes place from birth to childhood. The second stage of specialization begins with formal education and lasts until career trainings; it refers to the early experiences of work and life in which young adults start to develop two specialized learning abilities through interaction between the self and the environment. Those two specialized learning abilities make a specialized learning style (one of the four basic styles), and they tend to become a foundation for effective performance in early adulthood, including

in academic activities. The third stage is integration. It emerges from the complexity of work and life in adulthood that challenges the stability and achievement made through previous successes. Failure of new managers who have been promoted to initial management positions and who need to use a different skill set (Hill, 2007) may exemplify such a challenging developmental situation.

2.5. Exploratory study in a context of higher education

Although learning environments for higher education may vary according to level of education (from undergraduate through graduate school), the understanding of learning styles is essential for learning enhancement (Sims & Sims, 1995). There are several studies of higher education that have focused on the relationship between learning styles and education (Anderson, 1995; Wooldridge, 1995; Sugarman, 1985; Fox, 1984; Pigg, Bush, & Lacy, 1980; Whitney & Caplan, 1976). Because undergraduate students typically are in the second stage of specialization, they learn through a process of developing specialization in particular learning abilities. In this respect, it will be important to understand the function of specialized learning styles in relation to development of learning skills. The aforementioned four hypotheses will be used to test this notion. Further, if university students exhibit their learning style tendency toward integrated learning in this stage of specialization, it will be crucial to understand how effectively or ineffectively their integrated learning styles work for learning-skill development.

The integration of learning abilities requires individuals to balance two dialectical learning abilities (Mainemelis et al., 2002; Kolb & Kolb, 2005) that may positively affect the development of their concomitant learning skills in the stage of integration. For instance, if a mature person who remained in the stage of integration developed three learning abilities, two of which appeared to be dialectically balanced, it would be presumed that this person would develop certain learning skills influenced by those three learning abilities. But, in

terms of learning-skill development in the stage of specialization, what if young adults such as university students have balanced learning styles in such a stage? In the present study, the following exploratory question was raised in the learning context of higher education:

How do balanced learning styles of university students impact the development of the 12 learning skills?

3. Methods

3.1. Sample and procedures

This study was part of a 2-year longitudinal project on the relationships between learning environment, student learning, academic skill development, and attitudes at a research university in the United States. There were 881 undergraduate students who had just entered the university as freshmen and were asked to participate in this research project. The students who showed interest in this project initially consisted of 310 freshmen with majors in 43 academic disciplines. Of these 310 students, 22 were eliminated because of missing data or lack of a consent form to participate in the research project. The rate of return was 35.2 %, and 288 students were finally included for data analysis

For this research, a survey packet was created that included a cover letter, questionnaires, and a consent form to participate in the project; this packet was first sent out to the 881 undergraduate students. To promote student participation, one of the project team members explained the scope of the project to targeted students in an entrance orientation for a freshman program, in two introductory chemistry classes for freshmen, and in a psychology class, with the cooperation of faculty in charge of such classes. Students who intended to participate in this research project were asked to return completed questionnaires with a signed consent document via the internal campus mail system or to drop them in a box placed in front of those classes in a 2-week period during the beginning of their first fall semester.

3.2. Measures

The Learning Style Inventory (LSI) and the Learning Skill Profile (LSP) were used to test the six hypotheses. These two instruments were designed to be conceptually consistent with Kolb's learning theory (Boyatzis & Kolb, 1991, 1995, 1997; Mainemelis et al., 2002). A difference in methodology between the LSI and the LSP contributes to decrease in the problem of common method variance (Mainemelis et al., 2002).

3.2.1. The Learning Style Inventory

The LSI was designed to examine differences in individual learning styles by using a forced-choice method. It measures individual learning orientation toward four learning abilities: CE (feeling), AC (thinking), RO (reflecting), and AE (acting). The LSI is composed of 12 questions, each of which asks the person to complete a sentence by ranking four choices that correspond to four learning abilities. For example, the first sentence in the LSI begins with "When I learn," and the four choices to be ranked are "I like to deal with my feelings," "I like to think about ideas," "I like to be doing things," and "I like to watch and listen." These four items reflect, in turn, the CE ability, the AC ability, the AE ability, and the RO ability of learning. The sum of a number ranked from "4 = you learn most" to "1 = you learn least" on each of four abilities represents the degree of how much a person relies on each of the four different abilities of learning. The scores that are subtracted from one sum to the other in the same learning dimension, that is, the value of AC - CE or that of AE - RO, describe a relative specialization between the two dialectical abilities. Both values vary between 36 and -36. The closer the value of AC - CE is toward 36, the stronger the specialization will be in AC versus CE in learning situations. In contrast, the closer (or smaller) the value of AC - CE is toward -36, the stronger the specialization will be in CE versus AC. Similarly, the closer the value of AE - RO is toward 36, the stronger the specialization will be AE versus RO; a larger negative value for AE - RO suggests the specialization in RO is stronger than that in AE.

This instrument was also designed to examine the tendency toward balance between two learning abilities in each of the two dialectical learning dimensions (Mainemelis et al., 2002). Such a degree of balanced learning orientation is illustrated by the absolute value of AC - CE (i.e., $|AC - CE|$) or of AE - RO (i.e., $|AE - RO|$) after adjustment for population variation (Mainemelis et al., 2002). When the absolute value comes closer to zero, it shows more balanced and more integrated learning orientation. In contrast, when the absolute value increases from zero, it describes more imbalanced and more specialized learning orientation.

The methodology used in the LSI relies on its forced-choice method, which can reflect the dialectical nature of human learning activities (Kolb, 1984; Hickcox, 1991) and effectively control response sets (Saville & Wilson, 1991). Although there have been criticisms of the LSI in the past (Kayes, 2002), the LSI is known as one of the most frequently used instruments to assess learning styles (Davies et al., 1997; West, 1982). The third version of the LSI applied in this study makes the changes in psychometrics indicated by the study of Veres, Sims, and Locklear (1991) showing that the earlier version of the LSI described high test-retest reliability.

3.2.2. The Learning Skill Profile

The LSP was invented to assess the level of development of the 12 learning skills: leadership, relationship, helping, sense making, information gathering, information analysis, theory building, quantitative analysis, technology, goal setting, action, and initiative (Boyatzis & Kolb, 1991, 1995, 1997). The LSP is composed of 72 items, each of which describes a certain skill or activity. The 72 items form twelve 6-item scales that are in accordance with the 12 learning skills. A card-sort method is adopted for this instrument through which persons are required to categorize 72-item cards into seven classes that correspond to their skill level, with a range from 1 to 7. In this range, 1 = no skill or experience in this area, 2 = now learning this skill or activity, 3 = can do this with some help

or supervision, 4 = a competent performance in this area, 5 = an above average performer in this area, 6 = an outstanding performer in this area, and finally 7 = a leader or creator in this area. The level of development of 1 learning skill rests on a total score of 6 items that are encompassed into 1 of 12 learning skills. The minimum developmental level of 1 learning skill is 6, and the maximum is 42.

The card-sort method requires detailed and thorough instruction of how to categorize each card properly. Thus, this original card-sort format was revised to a more conventional one using a 7-point Likert-type scale that would simplify survey administration and allow respondents to answer with ease. This revised method used paper sheets that described 72 items, and there was a blank box next to each skill statement. Respondents were required to fill in the box with the appropriate number from 1 to 7. Furthermore, the original LSP was designed to examine learning skills of adults, especially those who work for an organization. Because the context of this study was an academic learning environment, the descriptions of 8 items specifying organizational contexts were revised to properly match academic contexts for this research project. For example, the original statement “be aware of various issues in the *company*” was replaced with “be aware of various issues in the *university*.” The revised version of the LSP thereby focused more on examination of undergraduates’ academic learning skills than on adult learning skills in general.

Cronbach’s alpha for internal reliability coefficients for the sample of this study ($N = 288$) varied from 0.69 to 0.91, with an average of 0.80. For each of 12 learning skills, Cronbach’s alpha was as follows: leadership = 0.83; relationship = 0.79; helping = 0.76; sense making = 0.78; information gathering = 0.69; information analysis = 0.79; theory building = 0.82; quantitative analysis = 0.85; technology management = 0.91; goal setting = 0.75; action = 0.79; and initiative = 0.83. With the exception of information gathering, which was 0.69, the rest of the learning skills exceeded the minimum standard of 0.70 suggested by

Nunnally (1978).

The LSP and its earlier version, the Executive Skill Profile (Boyatzis & Kolb, 1995), have been used in several studies for the following purposes: educational program assessment (Boyatzis, Stubbs, & Taylor, 2002; Ballou, Bowers, Boyatzis, & Kolb, 1999); testing of the experiential learning theory (Mainemelis et al., 2002); development needs evaluation (Rainey et al., 1993); and expatriate cultural adaptation (Yamazaki, 2010).

4. Results

The correlation matrix and descriptive statistics for key variables appear in Table 1. The results of the regression analysis used for tests of the discussed four hypotheses are shown in Table 2. In addition, the freshmen participated in this study tended to learn by using the strong AC (thinking) abilities and the RO (reflecting) abilities, the combination of which made the assimilating learning styles (AC - CE = 9.86; AE - RO = 3.07).

 Insert Tables 1& 2 about here

4.1. Results of four hypotheses

Hypothesis 1 predicts that individuals will show a greater level development in the three interpersonal skills of leadership, relationship, and helping under, if they exhibit the learning specialization in the CE (feeling) ability more than the AC (thinking) one. As Tables 1 and 2 show, the relationships between each of the three interpersonal skills and AC - CE were negative and significant, respectively. In particular, such negative correlations in regard to the betas of AC - CE described in Table 2 indicate that the development of the three skills agreed with the decrease in the score of AC - CE (leadership = $-.14, p < .05$; relationship = $-.22, p < .001$; helping = $-.24, p < .001$). Thus, individuals who learn using the CE ability more than the AC ability would show more development of those three interpersonal skills. Accordingly, Hypothesis 1 received support.

Hypothesis 2 states that if individuals learn by specializing in the AC ability rather than the CE ability, they will display a higher degree of skill development in the three analytical skills of theory building, quantitative analysis, and technology. Results of the regression analysis illustrate that the AC - CE values were significant and positive in regard to all of three analytical skills (theory building = .30, $p < .001$; quantitative analysis = .33, $p < .001$; technology = .21, $p < .001$), as shown in Table 2. These results supported the prediction that individuals learning by means of the AC ability more than the CE ability would show greater skill development in those three analytical skills. Therefore, Hypothesis 2 was accepted.

Hypothesis 3 predicts that individuals will show a greater level of skill development in three perceptual skills (sense making, information gathering, and information analysis) provided that they learn through the RO (reflecting) ability rather than the AE (acting) ability. Results of the regression analysis described no significant relationship between those three perceptual skills and AE - RO (sense making = .10, $p > .05$; information gathering = .04, $p > .05$; information analysis = .07, $p > .05$), as illustrated in Table 2. Hypothesis 3 was rejected accordingly.

Hypothesis 4 predicts that the more individuals are inclined toward specialization in the AE ability versus the RO one, the greater their learning skill development in the three behavioral skills of goal setting, action, and initiative. The independent variable of AE - RO described a significant, positive influence upon goal-setting skills (beta = .16, $p < .05$) and initiative skills (beta = .15, $p < .01$) but no significance about action skills (beta = .03, $p > .05$). Hypothesis 4 was partially supported.

4.2. Results of exploratory study

The exploratory question raised in this study was made about how balanced learning styles of university students impact the development of the 12 learning skills. Table 3 depicts

results of the regression analysis in terms of this question.

 Insert Table 3 about here

Results in regard to the three interpersonal skills illustrate that $|AC - CE|$ had a significant and negative impact on skill development in respect to relationship ($\beta = -.14, p < .05$) and helping ($\beta = -.15, p < .05$); it did not significantly affect leadership skill development ($\beta = -.03, p > .05$). It is suggested that freshmen develop the two skills of relationship and helping more fully, if their learning styles become more balanced between AC (thinking) and CE (feeling) but there is no connection of their balanced learning styles in this dialectical dimension with leadership skill development.

Results in regard to the three analytical skills showed that there was a significant and positive influence of $|AC - CE|$ on skill development in theory building ($\beta = .22, p < .01$), quantitative analysis ($\beta = .19, p < .01$), and technology ($\beta = .22, p < .01$). In addition, results also illustrated that the $|AC - CE|$ significantly and positively affected skill development in information analysis of perceptual skill ($\beta = .18, p < .01$). It can be interpreted that the more balanced learning style between AC (thinking) and CE (feeling) abilities would hinder the freshmen from developing those three analytical skills and information-analysis skills.

In terms of three perceptual skills and three behavioral skills (Table 3), results indicated that $|AE - RO|$ had a significant and negative influence on development only of goal-setting skills ($\beta = -.12, p < .05$) and that there was no significance in other skill development. It is suggested that freshmen would develop goal-setting skills more fully by balancing AE and RO abilities, but the balanced learning styles in that learning dimension would be independent of development of the other two behavioral skills and the three perceptual skills.

5. Discussion

5.1. A summary of the hypothesis testing

According to the results of hypothesis testing, the following five conclusions may be drawn. First, specialization of the CE (feeling) ability more than the AC (thinking) ability is likely to lead to development of the three interpersonal skills of leadership, relationship, and helping. Second, specialization of the AC ability more than the CE ability tends to develop the three analytical skills of theory building, quantitative analysis, and technology. These two conclusions relate to the dialectical learning ability of AC - CE in terms of its concomitant six learning skills. Those conclusions are consistent with earlier research by Mainemelis et al. (2002), (although their study assimilated three perceptual skills into one learning-skill cluster as a dependent variable) and with that by Boyatzis and Kolb (1991).

Third, specialization of the RO (reflecting) ability versus the AE (acting) ability would be independent of development of the three perceptual skills of sense making, information gathering, and information analysis. This conclusion is derived from the results of the third hypothesis test, which are also similar to those of the study conducted by Mainemelis et al. (2002) but are partly different from results of the study of Boyatzis and Kolb (1991). Fourth, specialization of the AE ability versus the RO ability would involve developing the two skills of goal setting and initiative but not action skills. This fourth conclusion is largely consistent with that of the study by Mainemelis et al. (2002) with the exception of the action skills; it is also mostly consistent with the conclusion of the study by Boyatzis and Kolb (1991). The third and fourth conclusions are associated with the other dialectical dimension of AE - RO.

The fifth conclusion is based on the aforementioned conclusive statements with regard to which one of the two variables, AC - CE or AE - RO, more affects skill development. Figure 3 illustrates a change in betas as an indicator of the extent of the impact

of two independent variables, AC - CE and AE - RO, on the development of 12 learning skills; two lines representing AC - CE and AE - RO moved differently according to the degree of influence on the 12 learning skills. As shown in Figure 3, the AC - CE was more varied and lay more in a critical region ($p < .05$) than the AE - RO. The AC - CE was significantly related to the following nine learning skills: leadership, relationship, helping, information analysis, theory building, quantitative analysis, technology, goal setting, and initiative. The AE - RO significantly and positively affected the development of three learning skills: leadership, goal setting, and initiative. The fifth conclusion can be therefore drawn as follows: the specialization occurring in the dialectical learning dimension of AC - CE will be more influential in the development of learning skills than will that in the dialectical dimension of AE - RO

 Insert Figure 3 about here

5.2. Implications form the hypothesis testing results

The five conclusions can also be usefully linked with a pedagogical exploration seeking better instruction in terms of learning-skill development. They tell us what learning abilities should be used for development of certain learning skills. If university students wish or need to develop three interpersonal skills, three analytical skills, or two behavioral skills such as goal setting and initiative, they should intentionally use the CE, the AC, or the AE learning ability, respectively. Development of three learning skills—leadership, goal setting, and initiative—requires two learning abilities, as shown in Table 2 and Figure 3. Educators or instructors who help students with skill development should give them not only developmental opportunities but also useful words or instructions. For example, if a student is interested in leadership skill development, an instructor should tell him or her to use more feeling or be sensitive to others as well as to take more action. The instructor's explanation

about its mechanism may be beneficial and helpful to the student.

Additionally, Barnett (1994) argues that the principal purpose of higher education is development in critical thinking. Further, the National Postsecondary Education Cooperative Working Group (Hersh & Benjamin, 2002) illustrates that college experience potentially affects critical thinking together with problem solving, analytical and evaluative skills, and reasoning skills as the higher-order cognitive skills (out of the 12 important items that can be assessed as student outcomes). Thus, a question is raised about what college experience is beneficial to students with regard to their skill development. Because critical-thinking skills, analytical and evaluative skills, and reasoning skills are thought to require use of the AC learning ability, college or university students should intentionally employ and specialize in the AC learning ability in order to develop critical-thinking skills in higher education.

5.3. Implications from the exploratory study in higher education

The exploratory study points out the following three important results. First, the more balanced learning styles of $|AC - CE|$ of the freshmen increased development of the skills of relationship and helping. Second, they hindered development of the four skills: information analysis, theory building, quantitative analysis, and technology. Third, the more balanced learning styles of $|AE - RO|$ increased development of goal setting only. The second result should be noted in particular. It suggests that university students who tend to be specialized in two dialectical learning abilities, especially in the learning dimension of AC - CE, may suffer in regard to development of three analytical skills and information-analysis skills. This suggestion seems to be important for university students who wish to develop three analytical and three interpersonal skills simultaneously. To be more precise, university students as young adults should avoid learning by balancing two dialectical learning abilities: AC and CE, for the development of those skills at the same timing. Instead, they should focus on either analytical or interpersonal skills and then should intent to use one of the two dialectical

learning abilities in relation to their learning-skill development.

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Table 1

The correlation matrix and descriptive statistics for all key variables

Key Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1 CE	23.81	6.06																			
2 AC	33.49	6.91	-.41**																		
3 RO	29.82	6.71	-.29**	-.34**																	
4 AE	32.89	6.36	-.20**	-.34**	-.41**																
5 AC - CE	9.68	10.91	-.82**	.86**	-.06	-.10															
6 AE - RO	3.07	10.99	.06	.01	-.85**	.83**	-.03														
7 AC - CE	10.23	6.81	-.28**	.55**	-.16**	-.17**	.51**	.00													
8 AE - RO	9.10	6.80	.07	-.03	.35**	-.40**	-.06	-.45**	.04												
9 Leadership	27.03	6.20	.20**	-.04	-.23**	.09	-.14*	.19**	-.03	-.06											
10 Relationship	30.08	5.12	.23**	-.15*	-.10	.05	-.22**	.09	-.14*	.05	.65**										
11 Helping	28.81	5.25	.23**	-.18**	-.08	.06	-.24**	.09	-.15**	.02	.66**	.84**									
12 Sense making	27.32	4.79	.08	.16**	-.20**	-.04	.06	.10	.10	-.06	.53**	.52**	.56**								
13 Information gathering	25.01	5.11	.10	.07	-.11	-.05	-.01	.04	.08	-.04	.54**	.54**	.61**	.73**							
14 Information analysis	26.53	4.90	-.07	.25**	-.16**	-.04	.20**	.07	.18**	-.08	.51**	.41**	.43**	.71**	.71**						
15 Theory building	26.29	5.11	-.09	.39**	-.24**	-.09	.29**	.09	.22**	-.05	.43**	.37**	.39**	.76**	.64**	.77**					
16 Quantitative analysis	26.64	5.43	-.19**	.35**	-.09	-.12**	.33**	-.02	.18**	-.03	.17**	.12	.13*	.54**	.43**	.60**	.74**				
17 Technology	23.33	7.58	-.10	.24**	-.09	-.06	.21**	.02	.22**	-.05	.02	.03	.05	.36**	.42**	.41**	.44**	.48**			
18 Goal setting	28.31	4.61	-.12*	.14*	-.12*	.09	.16**	.13*	.09	-.11*	.53**	.46**	.49**	.59**	.53**	.65**	.61**	.44**	.15**		
19 Action	28.64	5.24	-.02	.03	-.08	.08	.03	.10	.05	-.08	.51**	.47**	.50**	.55**	.56**	.66**	.53**	.35**	.10	.74**	
20 Initiative	28.38	5.35	.18**	-.09	-.22**	.15*	-.16**	.22**	-.01	-.05	.74**	.62**	.62**	.63**	.56**	.57**	.50**	.29**	.06	.65**	.67**

Note. $N = 288$. AC = abstract conceptualization; AE = active experimentation; CE = concrete experience; RO = reflective observation.

* $p < .05$; ** $p < .01$.

Table 2

Results of regression analysis for specialization of learning abilities

Skills Areas	<u>Interpersonal learning skills</u>			<u>Perceptual learning skills</u>			<u>Analytical learning skills</u>			<u>Behavioral learning skills</u>		
12 skills as dependent variables	Leadership	Relationship	Helping	Sense making	Information gathering	Information analysis	Theory building	Quantitative analysis	Technology	Goal setting	Action	Initiative
	β	β	β	β	β	β	β	β	β	β	β	β
AC - CE	-.14*	-.22***	-.24***	.06	-.01	.20***	.30***	.33***	.21***	.16**	.03	-.15**
AE - RO	.19***	.08	.07	.10	.04	.07	.10	-.01	.02	.13*	.09	.22***
<i>F</i>	8.27***	8.26***	9.54***	1.92	.26	6.58**	15.12***	17.18***	6.36**	6.39**	.89	11.08***
<i>df.</i>	2, 285	2, 285	2, 285	2, 285	2, 285	2, 285	2, 285	2, 285	2, 285	2, 285	2, 285	2, 285
<i>R</i> ²	.06	.06	.07	.01	.00	.04	.10	.11	.04	.04	.01	.07
Adjusted <i>R</i> ²	.05	.05	.06	.01	-.01	.04	.09	.10	.04	.04	.00	.07

Note. *N* = 288. AC = abstract conceptualization; AE = active experimentation; CE = concrete experience; RO = reflective observation.

p* < .05; *p* < .01; ****p* < .001.

Table 3

Results of regression analysis for integration of learning abilities

Skills Areas	<u>Interpersonal learning skills</u>			<u>Perceptual learning skills</u>			<u>Analytical learning skills</u>			<u>Behavioral learning skills</u>		
12 skills as dependent variables	Leadership	Relationship	Helping	Sense making	Information gathering	Information analysis	Theory building	Quantitative analysis	Technology	Goal setting	Action	Initiative
	β	β	β	β	β	β	β	β	β	β	β	β
AC - CE	-.03	-.14*	-.15*	.11	.09	.18**	.22**	.19**	.22**	.09	.06	-.01
AE - RO	-.06	.05	.02	-.07	-.05	-.09	-.06	-.03	-.06	-.12*	-.08	-.05
<i>F</i>	.58	3.16*	3.42*	2.17	1.31	6.05**	7.64**	5.13**	7.68**	3.18*	1.34	0.36
<i>df</i>	2, 285	2, 285	2, 285	2, 285	2, 285	2, 285	2, 285	2, 285	2, 285	2, 285	2, 285	2, 285
R^2	.00	.02	.02	.02	.01	.04	.05	.04	.05	.02	.01	.00
Adjusted R^2	.00	.02	.02	.01	.00	.03	.04	.03	.04	.02	.00	.00

Note. $N = 288$. AC = abstract conceptualization; AE = active experimentation; CE = concrete experience; RO = reflective observation.

* $p < .05$; ** $p < .01$.

Figure 1. Kolb's experiential learning theory: learning abilities and learning styles.

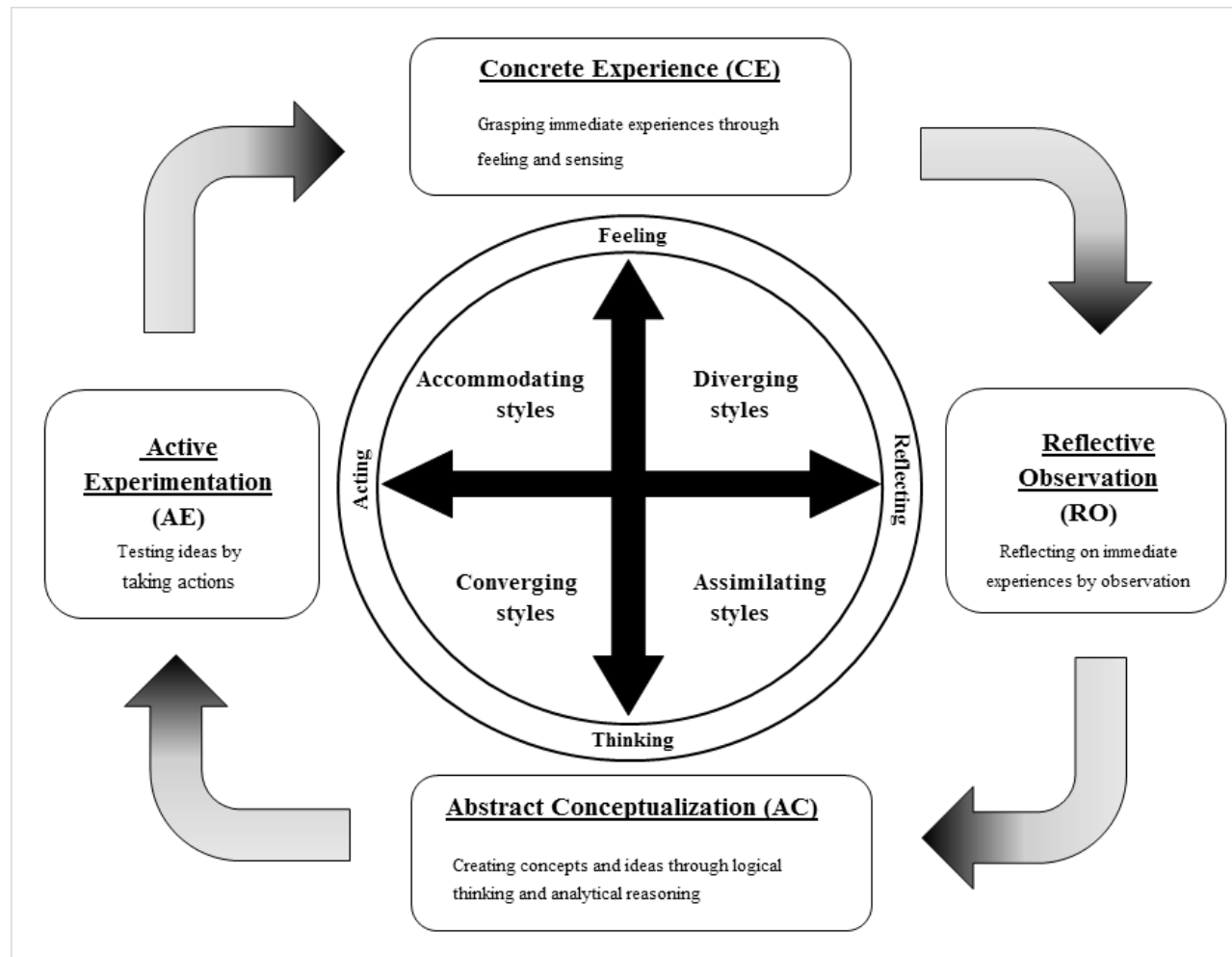


Figure 2. Kolb's learning skill model: 12 learning skills and four learning abilities.

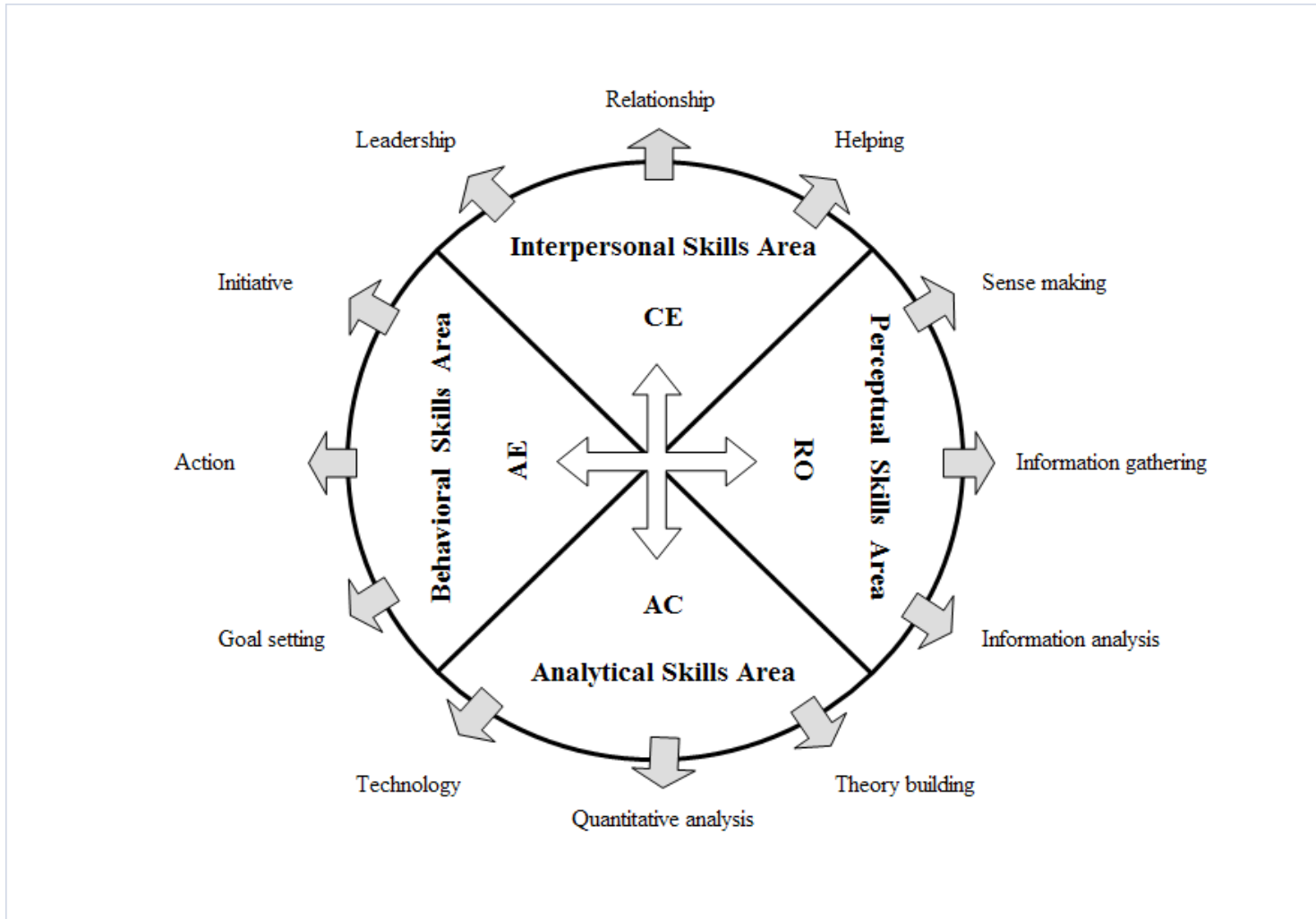


Figure 3. Change in betas of AC - CE and AE - RO affecting 12 learning skills.

