Students' learning styles and their correlation with performance in architectural design studio

Thomas Kvan and Jia Yunyan, Department of Architecture, University of Hong Kong, 3/F Knowles Building, Pokfulam Road, Hong Kong

Architectural curricula and studio design programmes are typically written with concerns for theoretical and professional training in mind without attending to ways in which a particular problem may privilege some students. Using Kolb's model, this study explores learning styles of architectural students in China and correlates their learning styles with design studio performance. A statistically significant correlation is found between learning styles and academic performance, with convergers achieving significantly lower marks in one studio while assimilators succeeded in the other. These results suggest that architectural studio programmes can disadvantage students with particular learning styles.

Keywords: architectural design, design education, learning style

The teaching method employed in design studios has a long tradition in architectural education and has been held up as an exemplar for teaching in other disciplines (Boyer and Mitgang, 1996). The design studio is the locus of architectural design learning and teaching, a setting where students communicate with one another and receive comments from the tutor. Schön (1985) identified that learning in design studio begins with ill-defined problems, a general characteristic of professional education, and observed that learning in the studio developed through a process he called 'reflection-in-action'. Schön also noted that the studio-teaching method could be generalized to all professional education (Schön, 1983). For all this prominence, we still do not understand much that happens in design studio learning and research into learning processes in the studio is an area of rewarding research.

Much has been written about the context and activity of studio teaching, yet few have considered the question of how students learn before

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advising on how to teach. Although there are many educational theories regarding individual differences among learners (Dunn and Dunn, 1975) and the role of experiential learning (Chickering, 1977), few have been applied to architectural education. Newland et al. (1987) conducted a study exploring the learning styles, perception and cultural bias of architectural designers from which they identified four kinds of designers in relation to learning styles: common sense learners, dynamic learners, contemplative learners, and zealous learners. Others have employed the Myers-Briggs-type indicator (MBTI), based on Jung's (1923) model of psychological types, to identify character and temperament profiles through questions about habitual behaviors (McCaulley, 1990; Brown et al., 1994). Using this instrument, Brown et al. found that the preferred profiles in their sample of landscape architecture students were intuitive-thinking and intuitive-feeling types. Demirbas and Demirkan (2003) evaluated the effects of learning style preferences on the performance of design students using Kolb's Experiential Learning Theory (Kolb, 1984); they found that there were significantly fewer students with the accommodating learning preference than other learning styles; in their sample, most students were assimilators and convergers. Their results indicated statistically significant differences between the performances of students with different learning styles in different stages of the design process. Since their study shares several similarities with this current study, it is discussed in detail later in this paper.

Schön illustrated his observations on studio teaching with the exchange between one student and one tutor and did not articulate differences among individual design learners. This research reports on a study of learning style distribution of architectural undergraduates and the correlation between learning styles and performance in architectural design studio. The identification of learning styles is based on Kolb's Experiential Learning Theory. Two programs from one of the eight oldest architectural schools in China are compared in terms of learning styles and the performance of students in the studio.

1 *Experiential Learning Theory and its application*

Kolb (1984) reports that he developed the Experiential Learning Theory from the works of Lewin (1948), who proposed that learning is best facilitated by an integrated four-staged cycle, Dewey (1934), who states learning is a dialectic process integrating experience with concepts, observations, and action, and Piaget (1970), who viewed the learning process as a four-stage cognitive growth process. From these foundations, Kolb developed his model of learning as a four-stage cycle (Figure 1) comprising *concrete experience* (CE), *reflective observation* (RO),

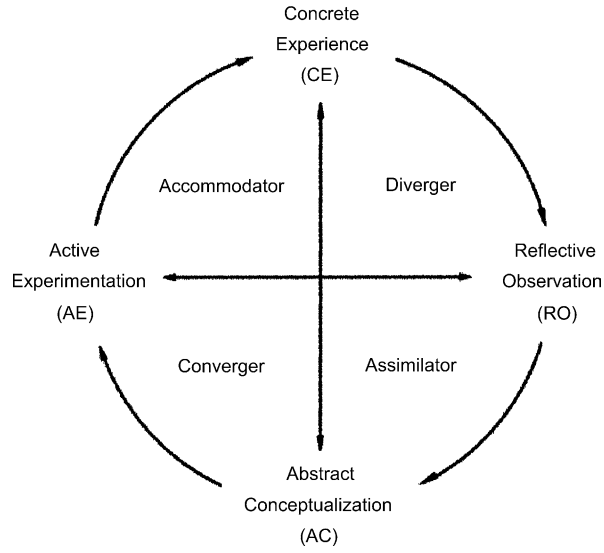

Figure 1 The four-staged learning cycle and the four learning styles (Kolb, 1984)

abstract conceptualization (AC), and *active experimentation* (AE). Kolb develops two dimensions from the four stages in the learning cycle. He suggests that the CE dimension is dialectically opposed to AC, and likewise RO to AE. From their life experience and innate characteristics, individuals will develop preferences for one or two particular phases of the four in the learning cycle. Learners can thus be classified into one of four learning styles, namely, converger, diverger, assimilator, and accommodator, mapped in one of the four quadrants (Kolb, 1985).

- *Convergers* combine AC and AE. Convergers are best at finding practical use to theories and ideas and are good at solving problems and making decisions. Kolb suggests they prefer dealing with technical tasks than with social and interpersonal issues.
- *Divergers* combine CE and RO. Divergers are best at viewing concrete situations from different points of view, they prefer brainstorming situations to taking action.
- *Assimilators* are learners who combine AC and RO. Assimilators are best at understanding a wide range of information and organizing them into concise, logical form. They are more interested in abstract ideas and concepts rather than people. They value more of the logical soundness of a theory than its practical value.
- *Accommodators* are learners who combine the learning steps of CE and AE. Accommodators learn primarily from 'hands-on' experience. They prefer to act on feelings rather than on logical analysis. In

solving problems, they rely more heavily on people for information than on their own technical analysis.

Experiential learning theories have been applied in a variety of professional education contexts (Geary and Sims, 1999; Brower et al., 2001; Kolb et al., 2001). More than 800 papers have been published between 1985 and 2002 in which Experiential Learning Theory is applied in tertiary education, covering the disciplines of education, management, computer science, psychology, medicine, nursing, accounting and law (Kolb and Kolb, 2002). Learning styles have also been used to predict students' academic achievement (Kruzich et al., 1986); for example, Chou and Wang (1999) found that one dimension of Kolb's learning style, information processing, has a significant correlation with learning performance.

1.1 Learning style inventory

Several instruments have been developed for assessing learning styles based on the Experiential Learning Theory. The most widely used is Kolb's Learning Style Inventory (K-LSI (II)) (Kolb, 1985). This is a revised version of the original K-LSI (I) released in 1976. The K-LSI (II) has been proved to have an improved internal consistency of the scales (Sims, 1986; Veres et al., 1987).

Honey and Mumford (1986) developed the Learning Style Questionnaire (LSQ) as an alternative to the K-LSI (II). Allinson and Hayes (1988) compared the LSI (II) and LSQ and concluded slightly in favor of the LSQ. More recently, researchers examined a larger sample size and concluded that the LSQ is not a satisfactory alternative to the K-LSI (II) in that it is not consistent with its theoretical framework (Cockerton et al., 2002; Duff and Duffy, 2002).

The K-LSI (II) consists of 12 questions in which respondents try to describe their learning preferences. Respondents are required to rank-order four sentence endings that correspond to the four learning styles. The activity of ranking the items in each row (forced scaling) is conceptualized as paralleling the learning process itself in that it forces participants to choose between contrasting abilities. As the four-stage learning model reflects abilities that are polar opposites (CE/AC vs. RO/AE), the learner must continually choose between these sets of learning abilities. By calculating the scores for AE−RO and AC−CE, the respondent can be mapped into one of the four quadrants, each representing one of the four learning styles (Kolb, 1985; Smith and Kolb, 1996).

The validity of the Kolb instrument has been challenged; Newstead (1992) declared that the reliability of the LSI was poor to moderate and its validity unproven. Coefficient studies have showed, however, that performance on one item in K-LSI is a good predictor of performance of any other item in the same instrument. Sims et al. (1986) found that the internal reliability of the K-LSI (II) sub-scales ranged from 0.76 and 0.85 and test–retest indices of 0.24 to 0.66 using a sample of 438 business undergraduates and postgraduates. Results of research with a sample of 187 Arts and Science students in an Australian university (Willcoxon and Prosser, 1985) indicate high internal consistency of the LSI (II) scales and some evidence of validity. Demirbas and Demirkan (2003) also found supportive results of K-LSI (II) through Cronbach alpha reliability analysis and Pearson correlation tests among learning modes and combined scores using the sample of 83 fresh architectural undergraduates.

1.2 Cross-cultural validity of the K-LSI (II)

In our study, the Kolb-LSI (II) was translated into Chinese before administering to subjects. The master version employed plain formulations without culturally loaded idioms. The translation was checked by two bilingual experts and revised according to their suggestions. A pilot study was run of the translated versions with Chinese students who were asked to identify any difficulties or ambiguities they met in understanding and answering questions. We did a back-translation in later stages of the analysis to check items that might produce unexpected results. These tests confirmed that the translation was valid.

The K-LSI (II) has been used in a wide range of cultural backgrounds (Duff et al., 1992; Demirbas and Demirkan, 2003). In research, in the learning styles of Chinese nursing faculty, Duff et al. (1992) translated the K-LSI (II) into Chinese and administered it to 36 members of nursing faculty of a medical college in China. Despite the cultural differences between China and Western countries, they identified a similar learning style distribution in their sample compared with several studies in Western cultures. This result suggests additional evidence of validity of K-LSI (II) used in the culture of China.

1.3 The shifted axis

A two-dimensional map of learning space is used in the Kolb model to map differences in the four learning styles (Kolb, 1984). The scores of CE are negatively correlated with AC, and scores of AE to RO, giving a single coordinate (AC–CE, AE–RO), mapping a learner in the learning space of the four learning styles. Prior studies (Kolb,

1984) have indicated that the correlations (AC−CE, AE−RO) in an empirical sample are more negative than those from random sample. Thus, it is normal practice in the Kolb model to shift the axes that distinguish the learning spaces of the four learning styles from the zero point to an empirical norm (AC−CE = 3−4; AE−RO = 5−6), a coordinate derived from the results of 1446 adults ranging from 18 to 60 years of age and a wide range of occupations and educational backgrounds (Kolb, 1985). We have adopted the axis shift in this study.

2 *The research*

In this research, we examined students currently engaged in architectural education in China and correlated their learning styles to their academic performance in design studio over the course of one semester. A total of 91 undergraduates in Years Two and Three in the Architectural School of Chongqing University took part in this study. The subjects were asked to complete the Chinese translation of Kolb-LSI (II) at the end of the programs. Their academic performance was obtained from grades collected from official academic performance records. All participants were informed that the questionnaire was part of a research project and were advised of their rights as human subjects. Students were given detailed instructions on how to complete the questionnaire and how to record their responses on the scoring sheets appropriately.

2.2 *The two programs*

The design tasks were set out in two studio programs, one for each year, respectively. Program 1, the last design project of Year Two studio, asked the students to design a kindergarten in nine weeks. Program 2 required Year Three students to plan a domestic residence in eight weeks. The information provided in the program brochures is summarized in Table 1; more detailed sections are indicated by headings in which the details have been omitted.

The programs have points in common and some differences. The objectives of the two programs differ in that Program 2 allows for more flexibility in approach. The submission requirements are also somewhat different, Program 2 being more specific in required outcomes. Program 1 is more prescriptive, providing detailed functional requirements and areas, while in Program 2 students need to explore such issues. The processes for the two studios were similar to each other: in the first week, there was a lecture on design principles and basic service requirements. After the lecture, students had a chance to study the program, collect

Table 1 Summary of the two programs

Program 1: Design of a Kindergarten	Program 2: Planning of a Residence
Studio objectives: 4) To master the design principle and methods of a public building 5) To gain initial problem-analyzing and problem-solving skills 6) To learn the background knowledge of kindergarten design	Studio objectives: 1) To master the principle and methods of urban residence planning, environmental design, vertical design, and pipe network design 2) To learn the whole procedure of residence construction and the connection between general planning, controlled detail planning, residence planning, and housing design 3) To be familiar with various types of residential building, how they are combined on the site, and their advantage and disadvantage in land saving, volume-rate increasing, ventilation, lightening and view 4) To learn the history of China's residence construction, the current situation and policy of residence industrialization, and the principles of urban residence planning, construction and management
Design problems to be considered: 4) The physical and psychological characteristics of children 5) Function 6) Sunlight, ventilation, and security (comply with the design criteria)	Design problems to be considered: 6) Environment, energy-saving, sustainability 7) Society, relationship with community 8) Economic 9) Feasibility 10) Local culture
Function and area guideline (*Details omitted*) Rooms needed and area of each room (*Details omitted*)	Function and area guideline (*Details omitted*)
Submission requirement 1) Layout plan; 2) plans; 3) elevations; 4) sections; 5) detailed plan of activity room; 6) model; 7) text explanation of design concept, with area index	Submission requirement 1) Site analysis; 2) planning analysis; 3) general plan; 4) road system and vertical plan; 5) perspective drawing of individual building; 6) representative drawing of key landscape design; 7) model; 8) text explanation, with tables of comprehension are index, public facilities, and housing types
Process: 5) (1 week) Lectures, brainstorming 6) (3 weeks) first draft, concept modeling 7) (2 weeks) second draft 8) (2 weeks) formal draft 5) (1 designing week) final product drawing	Process: 5) (1 week) Lectures, concept draft 6) (2 weeks) first draft, proposal of planning 7) (1 week) second draft 8) (2 weeks) formal draft 5) (2 weeks) final product drawing
Reference (*Details omitted*)	Reference (*Details omitted*)

information, and engage in brainstorming. In the following stages, students gradually develop their design and they handed in their drafts three times during the semester. The last phase was to draft their final solutions. During the semester, students met with their tutor two mornings each week. There were public reviews after every submission of drafts, supplemented by frequent desk crits during which the tutor gave comments to the student individually.

2.3 The assessment criteria

Final products of both programs were assessed on the same criteria: oral presentation (10%); concept (30%); function (40%); drawing and model presentation (20%). There was a public jury at the end of the program after which the instructor and three external critics decided the mark; the final marks of students are calculated as 40% from instructor, 60% from external critics. These marks were transformed into nine grades based on the following ranges: A (93–100); B+ (88–93); B (83–87); B– (82–78); C+ (75–77); C (70–74); C– (65–69); D (60–64); F (59–0). There was an additional criterion that the coordinator should normalize the distribution of grades, with students with a grade of 'A' should be no more than 10%; students with a grade of 'F' should be no more than 10%. We observe here that the assessments are focused on the final products rather than on the process.

3 Findings

In Program 1, a sample of 43 undergraduates were administered the questionnaires, of which 37 were returned correctly completed and used for learning style distribution analysis, while only 32 filled in their names to enable subsequent correlation of their performance, of which 21 were males (56.8%) and 11 females (29.7%). The students ranged in age from 19 to 21. In Program 2, 48 undergraduates were administered the questionnaires, of which 44 were valid, 33 males (75%) and 11 females (25%); students' ages ranged from 19 to 22. One of the subjects was marked zero in Program 2 due to a failure to submit the final project; this mark was excluded in the analysis.

The learning style distribution for participants in the two programs is shown in Figure 2. In Program 1, there is only one converger (2.7% of the sample) and five accommodators (13.5%), many fewer than assimilators (13, 35.1%) and divergers (18, 48.6%); in Program 2 the percentages were similar: 2 convergers (4.5%) and 7 accommodators (15.9%), 18 assimilators (40.9%) and 17 divergers (38.6%).

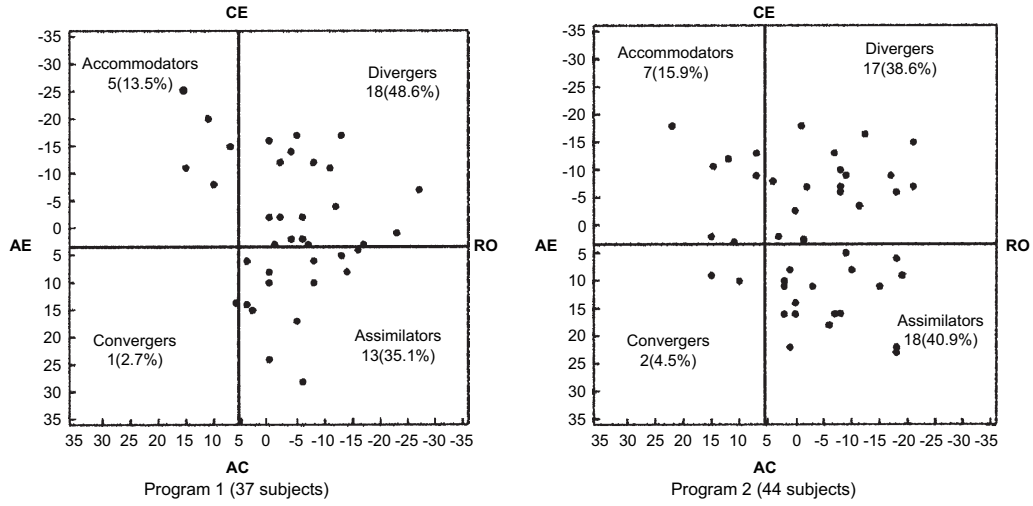

Figure 2 Learning style distribution of participants in Program 1 and Program 2

3.1 Correlation between learning style and performance

The means of the final marks have been calculated (Figure 3). To explore whether there is a correlation between learning style and academic performance in studio, a chi-square analysis was performed to test the correlation between the four learning styles and grades. The result showed that there are statistically significant correlations between learning styles and grades in both Program 1 ($a = 19.929$, df = 18) and Program 2 ($a = 24.715$, df = 21).

The small sample size precluded the use of an ANOVA test to explore whether there were significant differences between different styles of learners, so *t*-tests were used instead to see if there are significant differences between performances of students of every two different learning styles. With only one converger in Program 1 (who received the lowest mark), it was not possible to carry out a *t*-test on the sample.

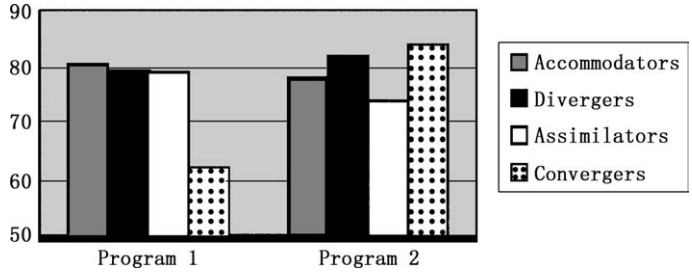

Figure 3 Performance means of different styles of learners

Valid *t*-test results of the data for Program 1 showed that there are no statistically significant differences between the performance of accommodators, divergers, and assimilators (Figure 4). In Program 2, the *t*-test results showed that there are significant differences between accommodators and the other three learning styles (Figure 4) and between divergers and assimilators. The result did not show a significant difference between the mean performance of convergers and assimilators, even though this difference appears to be significant in the bar chart; this may be because of the small sample size for convergers.

4 Discussion

While this research was underway, a similar study was published (Demirbas and Demirkan, 2003) based on the same theoretical basis (Kolb's Experiential Learning Theory), using similar subjects (Year One architectural undergraduates), with a similar sample size (83) as our research (81 Year Two and Year Three architectural undergraduates). Our study covers students participating in two programs engaged in ill-defined studio problems. Although their study is limited in scope, it is possible to compare our results with those of this recently published paper and draw comparisons from which some useful observations arise.

4.1 The comparing research

Demirbas and Demirkan designed a four-staged staircase program for research of performances. Students were to design a staircase in a prescribed volume. The first stage was to conduct research on staircases and prepare a report in one week. This was followed by a second stage in which there was a lecture and drawing exercise with instructions of detailed technical drawing rules in a 4-h studio session. In the third stage, students were assigned to build a model of the staircase. The fourth stage was to finish the orthographic drawing within 3 h. The product of each stage was assessed according to detailed criteria, mainly technical requirements such as listing the architectural components,

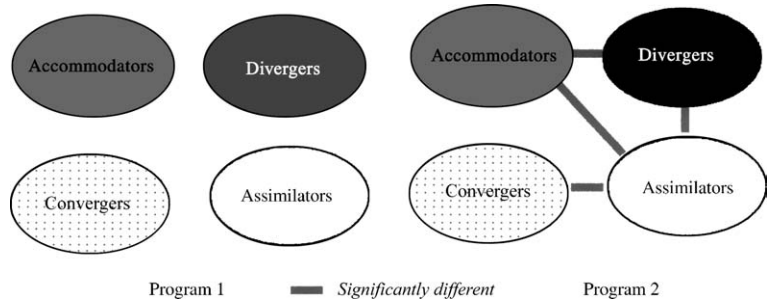

Figure 4 The t*-test results of different learners' performance*

correctness of the staircase, or completeness. The paper reports the distribution of learning styles in their sample as accommodator: 12.5%, diverger: 22.7%, assimilator: 31.8%, and converger: 33%. The assessments indicated that the mean performance of accommodators was significantly higher in stage 2 and the mean performance of assimilators was significantly higher in stage 3.

4.2 Distributions of learning styles

Kolb and Wolfe (1981) suggest that there are disciplinary differences in learning styles and that the dominant style in architects is accommodator (highly inclined to doing and slightly inclined to feeling). Our findings do not bear this out; in both programs of this research, as well as in that of Demirbas and Demirkan, accommodators were in the minority of the four learning styles (13.5%, 15.9%, and 12.5%, respectively). Another remarkable result is that covergers in the present study (2.7% in Program 1 and 4.5% in Program 2) are significantly fewer than in the Demirbas and Demirkan's sample (31.8%).

Subjects in both studies were students in junior years. Kolb suggests that learning styles are shaped gradually by individual experience; it may be that the proportion of accommodators may change over time. Teaching in secondary schools in China is primarily through lectures, in which students play a passive role during their learning experience. If the academic field of architecture is inclined to accommodators, students may experience a transition from reflective observation to active experimentation during their undergraduate study; in the two programs of this study, there seems to be some indication of this as the percentage of active learners increased from Program 1 (Year Two students), 16.2%, to Program 2 (Year Three students), 20.4%, but we note that this conclusion cannot be confirmed since the students in the two programs were not the same subjects of study here.

4.3 Culture and learning styles

The differences in learning style distribution between the present research and that of Demirbas and Demirkan may also be explained in terms of cultural differences. Hayes and Allinson (1988) conducted a study in which they explored the influence of cultural factors on learning styles, employing Hofstede's (1980) four-dimensional model to measure the differences in cultures. The dimensions used were Power Distance (concerned with human inequality), Uncertainty Avoidance (concerned with the tolerance for uncertainty), Individualism–Collectivism (concerned with the relationship between the individual and the collectivity which prevails in a given society), and Masculinity–Femininity

Table 2 Values of Hofstede's (2001) five dimensions of culture

Countries and Regions		PDI	UAI	IDV	MAS	*LTO*
Western culture	United States	40	46	91	62	29
	Great Britain	35	35	89	66	25
Chinese culture	Taiwan	58	69	17	45	87
	Hong Kong	68	29	25	57	96
	China	*Not included*	*Not included*	*Not included*	*Not included*	118
Mean scores of 53 countries and regions		57	65	43	49	*Not included*

From Hofstede (2001, p. 87, 151, 215, 286, 356). PDI—Power Distance Index Values; UAI—Uncertainty Avoidance Index Values; MAS—Masculinity Index Values; LTO—Long-Term Orientation Index Values.

(concerned with the extent to which the dominant values in society are 'masculine'). Hayes and Allinson concluded that culture accounts for differences in learning styles. If this is true, we observe that the empirical norm given by Kolb-LSI for discriminating the four learning styles may be problematic when using the instrument with a Chinese population. Further studies are needed to confirm whether there are any implications for cultural differences in the shifted axes of the Kolb-LSI instrument.

Hofstede (1980) added a fifth dimension in the revised edition of his work *Cultural Consequences* to the measurement of cultures: Long vs. Short-term Orientation (concerned with virtue as a goal). In the reported indexes of the five dimensions, countries with a Chinese culture score considerably lower on individualism and higher on long-term orientation than do those of the Western world (Table 2). On this dimension, Hofstede (2001) argues strongly for the non-universality of theory and practice. This would have important implications for architectural education on writing of design studio programs and raise questions about the suitability of western architectural design theories in design training in China. It may well be that the kind of learning environments and activities which promote effective learning in some cultures may not promote the same outcomes in other cultures where different learning styles predominate.

4.4 Ill-defined problems vs. well-defined problems

The performance of students in a studio may be related to the particular design program. The program used by Demirbas and Demirkan poses a well-defined design problem (Rowe, 1987) with a clearly delineated process that took students through a step-by-step problem-solving experience. The two programs in this research, typical studio programs

in architectural schools in China, began with ill-defined design problems and the whole process showed an integral evolution of design concepts and details moving from vague to clear, that is, they encompassed both the processes of problem framing and problem solving. Consequently, the durations of the two programs observed in this study were significantly longer than that of the staircase design task. This longer duration allowed for more undirected communication between students and engagement with various learning methods. The difference in duration of the task may provide an explanation to the different results in performance between the two studies. We may conclude that architectural studios in this sense accommodate a wider range of learning styles by virtue of their durations and instructional settings as well as the nature of design problems set.

4.5 Differences between the two programs

To explain the differences between performance results in Program 1 and Program 2, we looked into the difference between the two programs. In Program 1, the brief sets out detailed instructions on requirements and the size of each room; the program was therefore more prescriptive than that in Program 2. There is little problem analysis and decision making expected of the students. In such a context, convergers might be confused and discouraged in Program 1.

The submission requirements of the two programs may have some influence on the performance of students of different learning styles. We notice that the assessment criteria for Program 1 were closely aligned to the stated functional requirements and that the representation requirements are limited to plans and a model photo only, leaving the presentation of the concept to the oral presentation alone. As convergers are characterized by Kolb as keen on resolving problems and less interested in communication with people, the presentation requirements in Program 1 could put them at a disadvantage; however, our small sample size prevents us from drawing such a conclusion directly in this study. The submission requirements for Program 2 asked for two more conceptual drawings. Since assimilators are more interested in abstract ideas rather than working out concrete products, it was more difficult for them in Program 2 to finish the final product. It is possible that the product-based assessment criteria resulted in assimilators gaining lower marks.

5 Conclusions

From the findings of our study and through comparison between our study and that reported by Demirbas and Demirkan, we conclude that

a design studio can encompass a wide range of learning styles if its programs start from ill-defined design problems, permit a range of communication media and are engaged over a relatively long duration, hence allowing more freedom in learning approaches. This support for various learning styles may underlie Boyer and Mitgang's (1996) statement about the power and attractiveness of the studio-teaching model for other disciplines. The findings also suggest that the formulation of the design program and presentation requirements can disadvantage certain learning styles. In conclusion, these results provide a basis for the hypothesis that there is a significant correlation between learning style and students' academic performance in particular design studios. This study suggests that a test of learning styles can be conducted in the early phase of design studio and the awareness by the teacher of the need to accommodate diverse learning styles could result in different studio programs. Further studies are needed to observe the transition of learning styles during the architectural undergraduate education and to evaluate programs written to accommodate different learning styles. More research is also required into cultural dimensions of learning styles of architectural students.

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