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The Development of Online Learning Styles Inventory: An Exploratory Study

Yu-Ching Liu
Hsuan Chuang University
E-Mail: yuching@hcu.edu.tw

Yu-Chih Doris Shih
Fu-Jen Catholic University
E-Mail: dshih@mail.fju.edu.tw

Ryh-Wu Yeh
Hsuan Chuang University
E-Mail: bigbrotheryeh@hcu.edu.tw

ABSTRACT

This study intends to develop an online learning styles inventory. This paper reports the preliminary result of the development. We first developed 168 items, 105 items were selected for pilot study, and finally 64 items were chosen for the main study. The procedure of developing this inventory included expert evaluation, factor analysis, internal consistency reliability, and test-retest correlation. In order to improve the reliability and validity of the subscales, continuous empirical study is required.

Keywords: Learning Style, Inventory Development, Online Learning, Distance Education

INTRODUCTION

With the rapid advance in telecommunication techniques, many countries have adopted online learning (which is also referred to as e-learning) into school education and life-long learning, offering more diverse and convenient learning options for students. College institutions in Taiwan have followed such trend, and established various distance learning courses. However, is it suitable for all college students to take online learning

courses? According to some related studies, learning process is individualistic, which is affected by a person's cognitive ability, physiological state, motivation and emotion, and interaction between the instructional environment and teacher (Keefe, 1987). This shows we need to value students' individual differences. Before we can teach students according to their background and strengths, we have to identify students' different learning styles. In literature review, we have yet to locate published inventories for online learning styles. As different learning styles would affect students' learning effects, the present study recognized the importance to design an online learning styles inventory. Accordingly, instructors may use the outcome of the inventory to design effective e-learning courses for students of different learning style preferences. The objectives of the present study are:

1. Determine learning style categories for online learning assessment
2. Design items of online learning styles
3. Examine the validity and reliability of the online learning style inventory

LITERATURE REVIEW

Features and studies of online learning

With advances in information technology, online courses unrestricted by time and space are gaining increasing popularity among instructors and learners. Many teachers have also found learning effective through the use of Web 2.0 technology. For instance, there are positive reports on using Information and Communication Technology to support intentional learning (Oshima, Oshima, Yuasa, Konishi, Itoh, & Okada, 2008), the support of learning using weblogs (Juang, 2008), and the promoting of deep learning using Wiki (Chua, & Chua, 2008). Thadphoothon (2002) mentioned in their paper that "computer-mediated collaborative learning has the potential to enhance critical thinking in language learning" (p. 1491). Instructors can make good use of the discussion boards for students to think critically because it would involve writing skills and allow online class interaction. Students can act as moderators and carry out collaborative learning through interactive activities.

Features of online learning may be more suitable for some learners, for instance, shy, independent learners may find online learning more comfortable than traditional face-to-face learning environment. In addition, as compared with the traditional, systematic, linear teaching course design, online course arrangement may be more

appropriate for students with non-traditional and non-linear learning styles (Illinois Online Network, 2008). Communication in online learning relies mostly on writing abilities, and emphasizes on students' self-motivation and discipline (lack of teacher supervision due to unfixed classroom and class time) (Mupingo, Nora, & Yaw, 2006).

Unlike direct contact and interaction in traditional classroom instructions, online instructors may have no knowledge of learners' learning preferences or immediate responses to the instruction. If learners' learning styles were not known beforehand, it would be difficult for teachers to offer suitable teaching contents and arrangement according to learners' individual learning style preferences.

Definition and categorization of learning styles

In the past, school instruction is focused on course arrangements and teachers' instructional strategies, which is believed to be enough for effective learning. Afterwards, educationists understand that teaching quality is deeply affected by the student's characteristics, the teacher's teaching styles, and teaching environment (Keefe, 1987). A student's characteristics, in terms of learning styles, are referring to an individual's combination of stable cognitive, affective, and physiological states, thus the students' preferred behavior would be reflected on how they perceive, respond, and interact with the environment (definition of learning style in NASSP, from Keefe, 1987). Although "cognitive style" and "learning style" were known as synonyms in the past, learning styles not only include cognitive styles, but also the affective and physiological learning preferences.

Gregorc (1984) proposed that style reflects an individual's unique, systematic thoughts and modes of behavior. This is also the behavior model for environmental adjustment, formed from the interaction among an individual's genes, environment, and cultural factors. While style is a hypothesized constructive concept, understanding a person's learning style will be helpful to explain the learning process and further improve learning effects. If students are exposed to teaching methods inappropriate for their learning styles, this may result in affective and physiological perceptual problems (Gregorc, 1979).

Curry (1983) provided the analogy of the structure of learning style as to the peeling of onions. The core of the onion is an individual's basic "personality trait" and this trait measures how this individual accesses and integrates information. The second level is "information-processing," which focuses on the individual's information-processing and

cognitive preferences. The third one is "social interaction," that is, the effect from individual's interaction between learning environment and peers. The outer level is more focused on individual preferences for instruction and environment. Individual's learning style is stable and difficult to change near the core, while outer levels are prone to be changed with learning or experience.

The role of learning styles in learning and teaching

Individuals possessing different learning styles indicate respective learning styles preferences. However, preferences of different learning styles do not lead to different results in intelligence or academic performance. Dunn (1990) believed learning content or subject is not the cause of learning failure—if an instructor can teach with the styles the students are good at, anyone can learn effectively. Dunn, Griggs, Olson, Beasley and Gorman (1995) collected and analyzed 36 studies which adopted Dunn's learning style assessment tools from 1980 to 1990. Results showed students exposed to learning environments suitable for their learning styles, their average test grades and learning attitude were three-fourth standard deviation higher than those exposed to the unsuitable learning environment. In another study, individuals exposed to learning environments suitable for their learning styles showed improvement in scores (Dunn, 1990). Hence, if teachers understand the types of learning styles the students possess, and redesign or adjust the teaching methods to provide learning environment and media appropriate for students' specific learning styles, this may help to improve the learning results for learners who dislike traditional lecture-based courses. Therefore, diagnosis of students' learning styles provides useful information for educators to arrange or design suitable teaching methods and teaching environment according to students' individual differences (Keefe, 1987).

Assessment of learning styles

Among the commonly used tests or scales for learning style assessment, the earlier one is the *Group Embedded Figures Test* developed by Herman Witkin (1976) and his colleagues. Participants are asked to locate a specific shape in a complicated figure, in order to identify if an individual is field independent/analytic or field dependent/global in processing information. For learning style tests accessing personality, the *Myers-Briggs Type Indicator* (Myers, 1978), developed according to Jung's personality theory is able to identify four personality dimensions, extraversion—introversion, sensation—intuition,

thinking—feeling, and judging—perceiving. David Kolb (1976) developed a learning style scale according to his experience learning model. The model is a four-step cycle: from the steps of concrete experience, reflective observation, abstract conceptualization, and then to active verification. Students' learning preferences are then categorized as divergers, assimilators, convergers, and accommodators.

Dunn's *Learning Style Inventory* (for grades 3 through 12) measures 24 factors (Dunn, Dunn, & Price, 1981), and the *Productivity Environmental Preference Survey* (for adult learners) measures 21 factors (Price, Dunn, & Dunn, 1982). Besides different cognitive or perceptual styles, Dunn et al. believed that individuals may also differ in environment and social interaction preferences. An individual's learning styles may be divided into four main categories—environmental (sound, light, temperature, classroom design), emotion (motivation, persistence, responsibility, need for structure), sociological (working alone, with others, with an adult), and physical/perceptual preference (visual, auditory, tactile, kinesthetic, intake, time of day, need for mobility).

Keefe and his associates developed a *Learning Style Profile* for grades 6-12 students, measuring 23 factors in total—cognitive skills (analytic, spatial, discrimination, categorizing, sequential processing, memory), perceptual response (visual, auditory, emotive), persistence orientation, verbal-spatial, manipulative, study time (early morning, late morning, afternoon, evening), grouping, posture, mobility, sound, lighting, and temperature (Keefe & Monk, 1986).

Gregorc Style Delineator (Gregorc, 2004) measures cognitive preferences related to perception. It is divided into two dimensions: Concrete—Abstract, Sequential—Random, resulting in four learning styles: Concrete Sequential, Abstract Sequential, Concrete Random and Abstract Random.

The *Index of Learning Styles* was developed by Felder and Soloman in 1991 (Felder & Spurlin, 2005). It is an online instrument and can be submitted and automatically scored on the Web. It contains 44 items to assess preferences on four dimensions (active/reflective, sensing/intuitive, visual/verbal, and sequential/global).

Reliability of the learning style tests

The reliability of most of the learning styles inventories is moderate. The *Learning Style Inventory* developed by Dunn (1981) and his associates measures 24 learning styles, with low to moderate reliability coefficients. The authors reported in 1988 that the coefficient ranged from .55 to .88.

The internal consistency of the subscales of the *Learning Style Profile* ranged from .47 to .76, and the average coefficient was .61. The authors contributed this low average reliability to the small number of items that comprise for some sub-scales (Keefe & Monk, 1986).

The Cronbach's α of the *Index of Learning Styles* for the four dimensions ranged from .41 to .76; test-retest correlations (4-week, 7-week, and 8-month) were from .50 through .87 (Felder & Spurlin, 2005).

From the review of the literature, almost all of the existing learning style inventories are adopted in the traditional learning situations. Carnevale pointed out that most studies indicate that it is difficult to identify the specific learning styles possessed by the online students, which might have resulted from dispersed learning styles, or assessment tools adopted inappropriately for the e-learning environment (as cited in Mupingo, Nora, & Yaw, 2006). Therefore, it is important to develop a test appropriate for learners in online learning environment, and furthermore, the results of such test would allow the course designers to develop online courses suitable for learners of multi-learning styles.

METHODOLOGY

According to our research objectives, this section describes the ways we determined learning style categories for online learning assessment; designed items of online learning styles; and examined the validity and reliability of the online learning style inventory.

Determine the categories of online learning styles

Online learning features include learning in the unrestricted time and location, but it requires learner's learning self-management. The online learning contents allow multiple media elements such as audio-visual elements, graphics, textual information, and hyperlink functions. With reference to learning style categories in related learning style tests (for example, those from Dunn, Kolb, Keefe, Gregorc, Felder and Soloman), we identified three categories consisting of 15 factors in the learning styles inventory developed in the present study:

(i) Perceptual types (this refers to the preference of using particular perceptual sense in learning): 1. Text: preference for textual information in learning; 2. Visual: preference for figures and charts information; 3. Auditory: preference for sound and voice information; 4. Active: preference for touch, hands-on operation, and self-experience.

(ii) Cognitive processing types (this refers to the cognitive tendency for processing information): 1. Abstract: preference for abstract or conceptual methods for information process; 2. Concrete: preference for daily experience or concrete examples; 3. Serial: preference for serial and linear learning; 4. Random: preference for learning in a non-linear sequence or order; 5. Holistic/Global: preference for overall understanding of the information; 6. Analytic: preference for detail analysis of every part of the reading or information.

(iii) Social Interaction and Personality types (this refers to the preferences in social interaction and personal traits in learning condition): 1. Study alone: preference for solitary in learning; 2. Study with group: preference for interaction with peers; 3. Guided: preference for guidance or supervision by an instructor; 4. Persistence: the tendency to focus in learning in a lengthy amount of time; 5. Observer: prefers observation instead of involvement in discussion or interaction with others.

Design the items of the inventory

In consideration for a wider range of applications for learners in the future (especially for learners with no prior online learning experience), most items (i.e., the questions or statements) in our online learning styles inventory inquires learners' learning preferences in general learning situations. However, two or three items in each learning style factor measure the online learning situation by using terms like "When playing online games…", or "When searching for information online…" to assess participants' preferences in online learning or Internet experiences.

Examine the validity and reliability of the inventory

At the beginning, we developed 168 items. Items were assessed twice by three scholars in the fields of psychometrics, learning styles, and e-learning. After items were modified according to their feedback, the content validity of the scales is therefore assumed to be valid. In addition, the first draft of inventory was administered to five undergraduate students from different colleges in Taiwan. From their responses and suggestions, which included the clarification on certain terms and reduction to the number of items, 105 items were selected for the pilot test.

Pilot test sample. Pilot tests were distributed to undergraduate students of humanities, science, business, engineering, medicine and agriculture in 10 universities in different areas of Taiwan. A total of valid 372 questionnaires were returned.

Item selection for the main study. As the present inventory was developed to measure 15 factors of learning styles, these factors may be inter-correlated. When factor analysis was conducted with all of the data, the result did not show 15 distinct factors as we hypothesized. Therefore, we decided to conduct factor analysis within each subscale. Item selection for the main study was based on the results of the factor analysis and researchers' judgment. In addition, for each subscale, at least one online learning item was selected. Finally, 64 items were selected from 105 items, with four to five items for each learning style. There were five negative items in the scale.

Reliability analysis. Three reliability analyses were conducted in the present study. First, internal consistency reliability analysis of the 15 learning styles was conducted for the 105-item version, with 372 samples; second, a five-week interval test-retest reliability analysis was conducted with the 64-item version (participants were 35 humanities undergraduates in a private university); and third, internal consistency reliability analysis of the 15 learning styles was conducted for the 64-item version (participants were 137 humanities undergraduates in two private universities in North Taiwan, including the first set of responses from the test-retest sample).

RESULTS AND DISCUSSION

Result of reliability analysis for the 105-item learning styles inventory

Results of the 105-item internal consistency reliability analysis using 372 samples are shown in Table 1. For five of the 15 learning styles, the Cronbach's α was higher than .60; for another five learning styles, the Cronbach's α was between .50 and .60, and for the rest of the learning styles, it was lower than .50. The low to moderate reliabilities for the 105- items were similar to the results in the learning style inventories developed by Dunn et al. (1981) and Keefe et al. (1986).

Result of reliability analysis for the 64-item learning styles inventory

Overall, when we take out the data on 64-items from the 105-items inventory using the 372 samples, we found those with lower Cronbach's α (those less than .50) in the original 105-item analysis, such as Auditory, Concrete, Serial, were found improved (see Table 1). The coefficients of the test-retest reliability for the 35 samples on the factors of "Auditory," "Concrete," "Serial," "Random," and "Analytic" were raised (see Table 1).

When our inventory of 105 items was administered in numerous universities, many respondents expressed that there were too many items to be filled out. Consequently we tried to reduce as many items as possible in the revised version. Theoretically, with other factors remaining constant, Cronbach's α is lower with fewer items. However, in our study, when we reduce the items from 105 to 64, the low Cronbach's α for the factors of "Auditory," "Concrete," "Serial," and "Random" increased. This indicates the reduction of items improved the reliability of internal consistency.

As for the test-retest analysis, only "Active," "Holistic/Global" was less than .50, the Pearson correlation coefficients of the other 13 learning styles were more than .50 (see Table 1).

The results of reliability analysis of the Perceptual, Cognitive-processing, and Personality learning styles

Reliability analyses (both the internal consistency and test-retest reliability) showed moderate reliability in the category of Perceptual learning styles. Reliability is lower for Cognitive-processing learning styles, especially for "Serial," "Random," and "Analytic." Higher reliability was found in Social Interaction and Personality learning styles, including "Study alone" or "Study with group," "Guided," "Persistence," and "Observer" (the average α was .66 for the 372 samples in the 105-item; average α was .63 for the 137 samples in the 64-item, and the average Pearson correlation coefficient was .66 for the 5 weeks test-retest reliability).

Test results on gender differences

Results of the t-test on the 105-item inventory done by 372 samples showed males had significant lower scores than those of the females on "Auditory" learning styles, but higher scores on "Abstract," "Random," and "Analytic" learning styles (see Table 2). From this finding, we can see that the major difference in male and female learning styles lies in the cognitive-processing category. In other words, more male participants prefer to process information through abstract or conceptual methods. According to the results in Philbin, Meier, Huffman, and Boverie' study (1995), male adults are primarily abstract and reflective, and if the learning requires thinking and watching, they learn best; on the other hand, female adults learn better through watching and by doing. One other study administrated *Gregorc Style Delineator* on university Spanish-speaking students in Texas found males showed more preference with "Abstract" and "Sequential" learning styles,

and females had stronger preferences on “Concrete” and “Random” (Picou, Gatlin-Watts, & Packer, 1998).

Table 1 Reliability for the 15 factors of learning styles

	Sample of 372 participants		Sample of 137 participants	Sample of 35 participants
Factor of learning style	Internal consistency reliability (Cronbach’s α)			5-week test-retest reliability (Pearson *r)*
	105-items	64-items [a]	64-items	64-items
Text	.54	.54	.48	.52
Visual	.54	.54	.56	.77
Auditory	.37	.49	.59	.52
Active	.58	.54	.70	.45
Abstract	.74	.72	.67	.56
Concrete	.46	.72	.72	.51
Serial/Linear	.22	.37	41	.51
Random	.43	.48	.47	.59
Holistic/Global	.53	.52	.44	.49
Analytic	.35	.35	.49	.68
Study alone	.73	.67	.68	.73
Study with group	.72	.65	.76	.77
Guided	.72	.64	.59	.65
Persistence	.52	.45	.51	.53
Observer	.60	.57	.63	.60

[a]The calculation is based on the 64 items selected from the inventory of 105 items.
Note: This table shows the reliability results for the samples of 372 participants (on 105 items and 64 items respectively), 137 participants (on 64 items), and 35 participants (on 64 items).

Furthermore, our study showed that the males do not have to follow serial procedures or order in learning, but access different chapters or web pages randomly. And they prefer to analyze each part the information in detail instead of grasping the overall concept holistically at the beginning of their learning. On the other hand, female participants have higher scores in the "Auditory" factor than males. It appears that female students prefer voice and sound for receiving and processing information in learning when compared to male students. This is consistent with Honigsfeld and Dunn' finding that females in many nations have been more auditory than their male counterparts (2006).

As for the results from the 64-item inventory done by 137 samples, the outcome showed significant differences between male and female learning styles in "Abstract" and "Study with group" (see Table 2). That is, males prefer to process information in abstract or conceptual methods more than females in learning and this is consistent with the result of the 372 sample. In addition, male students prefer to interact and learn with peer more than female students during their learning, and a similar finding was found in Honigsfeld and Dunn' study (2003). Results from these two samples were not entirely consistent, which may be caused by sample differences (i.e., this sample was taken only from the humanities college), and differences in the number of items for both samples.

Test results on college differences

To examine learning style differences among different colleges, the present study divided the 105-item inventory done by 372 samples into 4 main college categories: Humanities College (n = 59, 15.9%), Business and Management College (n = 115, 30.9%), Science College (n = 40, 10.8%), and Engineering College (n = 157, 42.4%). Analysis of variance (ANOVA) was conducted, and the Scheffé post hoc test was applied for significant ANOVA results. The ANOVA results revealed significant differences among the colleges for the following factors of learning style: "Visual" ($F(3,357)=3.301$, $p<.05$), "Auditory" ($F(3,358)=3.207$, $p<.05$), "Abstract" ($F(3,361)=8.880$, $p<.001$), "Analytic" ($F(3,358)=3.352$, $p<.05$), and "Guided" ($F(3,365)=7.043$, $p<.001$) (see Table 3).

Table 2 Results of gender difference on learning styles

Factor of learning style	Sample of 372 participants (105-items)				Sample of 137 participants (64-items)			
	Male M^a	Female M	t^b	p^c	Male M	Female M	t	p
Text	3.28	3.26	.36	.72	3.33	3.32	.159	.88
Visual	3.60	3.55	1.07	.29	3.63	3.79	-1.59	.12
Auditory	3.50	3.60	-2.13*	.03	3.69	3.81	-1.11	.27
Active	3.73	3.69	.80	.42	3.95	3.79	1.27	.21
Abstract	3.42	3.29	2.28*	.02	3.32	3.02	2.57*	.01
Concrete	3.63	3.68	-1.13	.26	4.03	4.13	-1.07	.29
Serial/Linear	3.23	3.24	-.17	.87	3.52	3.60	-.90	.37
Random	3.41	3.28	2.44*	.02	3.56	3.39	1.56	.12
Holistic/Global	3.48	3.49	-.18	.86	3.49	3.49	.01	.99
Analytic	3.27	3.17	2.18*	.03	3.22	3.10	1.17	.25
Study alone	3.16	3.21	-.74	.46	3.23	3.45	-1.58	.12
Study with group	3.44	3.36	1.16	.25	3.72	3.44	2.15*	.03
Guided	3.36	3.34	.36	.72	3.44	3.59	-1.34	.18
Persistence	2.85	2.95	-1.76	.08	2.76	2.92	-1.22	.22
Observer	3.14	3.09	.74	.46	3.15	3.17	-.13	.89

*p <.05

Note: [a] M= mean, [b] t= t-score, [c] p= p-value

Results of the Scheffé post hoc test (the most conservative method, Huck, 2000) revealed only four learning styles factors showed significant differences between groups ("Auditory," "Abstract," "Analytic," and "Guided"): First, the Science College sample yielded significant lower scores in "Auditory" learning style than the Business/Management and Engineering College samples; second and third, the Engineering College samples showed significant higher "Abstract" learning style scores

than Humanities and Business/Management College samples, and significant higher "Analytic" learning style scores than the Business/Management College samples; and lastly, the Business/Management College samples obtained the highest scores in "Guided" learning style among the college samples.

Table 3 Results of college difference on learning styles

Factor of learning style	Humanities	Business/ Management	Science	Engineering		
		M			F^a	*p*
Text	3.25	3.22	3.35	3.28	.78	.51
Visual	3.48	3.52	3.67	3.63	3.30*	.02
Auditory	3.55	3.57	3.35	3.58	3.21*	.02
Active	3.68	3.76	3.66	3.70	.65	.58
Abstract	3.15	3.23	3.46	3.50	8.88***	.00
Concrete	3.69	3.68	3.55	3.65	1.34	.26
Serial/Linear	3.22	3.26	3.19	3.24	.41	.75
Random	3.31	3.32	3.38	3.37	.37	.78
Holistic/Global	3.47	3.49	3.34	3.54	1.95	.12
Analytic	3.17	3.14	3.30	3.29	3.35*	.02
Study alone	3.30	3.12	3.27	3.16	1.15	.33
Study with group	3.32	3.45	3.20	3.45	2.45	.06
Guided	3.20	3.52	3.21	3.31	7.04***	.00
Persistence	3.01	2.89	2.86	2.88	.90	.44
Observer	3.05	3.09	3.16	3.15	.77	.51

*p <.05, ***p <.001
Note: [a]F= F score

These results indicated that Science students do not prefer to receive information through auditory than Engineering and Humanities students. Engineering students prefer to think more abstractly and conceptually than Humanities, Business and Management

students, and emphasize more in analyzing detail parts of each section. This may be related to the study of more abstract theories in physics and chemistry for engineering students, hence requiring the need to verify experimental procedures or formula. In addition, Business and Management students are in favor of being guided or supervised by an instructor in learning than students in the other colleges. This may be due to the emphasis of team work and supervision in business and management field. A study in Singapore by Yuen and Lee (1994) revealed the similar results: The students who were in social and humanities fields showed more preferences in the category of "Diverger," that is, they were concrete experiencer and reflective observer; as for the science students, they tended to be "Assimilators," which means they preferred abstract thinking and conceptualized their understanding.

CONCLUSION AND RECOMMENDATIONS

In the present study, we made an attempt to develop an online learning styles inventory. We referenced important factors in learning style inventories in literature, and with consideration of e-learning features, 15 factors (105 items in total) related to e-learning styles were selected from the original 168 items. Results of the internal consistency from the pilot sample showed higher reliability, close to .60 or .70, in "Active," "Abstract," "Concrete," "Study alone," "Study with group," "Guided," and "Observer" styles. However, lower reliability, mostly less than .50, was shown in "Auditory," "Serial," "Random," and "Holistic/Global" styles. After factor analysis and researchers' judgment, 105 items were reduced to 64 items (with 4 to 5 items in each factor). A new sample test and a 5-week test-retest reliability analysis were conducted. Learning style factors with lower reliability value in the 105-item scale showed increase in this shortened scale.

Reliability study of the present inventory of learning style preferences is at the beginning phase. The reliability coefficients of the sub-scales in this inventory range from low to moderate. In order to improve the reliability of the scale, continuous empirical study to verify the reliability and consistent item revision are required.

Results of learning style differences in the pilot test (105-item filled out by 372 participants) and the second undergraduate samples (64-item filled out by 137 participants) showed significant differences in gender and college in some learning styles. As the present inventory is still at the development stage and the number of samples accumulated is small, hence, more studies need to be conducted to establish norms for

different types of participants in the future.

The present inventory has 15 factors (in three large categories) which are related to the online learning situation. It can help instructors or online course designers understand students' preferred learning styles in the dimension of the perceptual types, cognitive processing types, and Social Interaction and Personality types, as a reference to design suitable courses and adopt appropriate teaching methods. For example, for students who preferred to learn through auditory materials, the online course should include various types of audio files such as teachers' lectures in audio formats and guest speakers' speech contents; for learners who prefer active learning, instructors should offer more materials such as 3D animations and/or online puzzles; for those who like to study with peers, teachers should increase the opportunities for synchronous discussion (e.g, via MSN Messenger or JoinNet videoconference programs); for the ones who need to be monitored constantly in their learning process, the course designers should include checklists and assessments to guide them. Furthermore, the results obtained from the inventory can also be used to compare with students' learning performances in order to improve the contents of the online course. However, it should not be used exclusively for student selection or categorization. In order to better stabilize and improve this inventory, more studies are needed to examine its validity and reliability.

The researchers have been collecting data on the relationships between students' learning styles and their grades, such results can be the evidence of criterion-related validity. In addition, future studies on assessing learning styles of students across different cultures may also be explored. These findings will be valuable to teachers who offer online courses to students of diverse backgrounds.

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