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Success in Distance Education: Do Learning Styles and Multiple Formats Matter?

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Abstract: Using data collected from 120 students enrolled in nine sections of an undergraduate technical communication course, this study found a number of statistically significant associations between students' learning styles, as defined by the Index of Learning Styles, and nine measures evaluating both academic performance and student preference. The study also measured student performance in collaborative and self-directed versions of the course, as well as full and summer sessions. Reflective learners were found to be the most successful online learners, excelling in collaborative, as well as self-directed versions of the course. Sequential learners also outperformed global learners. Learning styles were not a significant factor in summer-session courses.

As early as 1983, Moore found a positive relationship between field independence and student learning in independent study environments. Since then, interest in the relation between success in distance education and learning styles more generally has widened, as demonstrated by the meta-analysis by Allen et al. (2002). Comparing student satisfaction in online vs. traditional courses, the researchers postulated the influence of learning style in distance education. Recent publications supporting this influence include the following:

- A compatible learning style as a factor responsible for student readiness (Eastmond 2000, 349);
- A relationship between students' personality traits, such as extrovert, introvert, sensing, and thinking, and success in distance education (Irani et al. 2003; Soles and Moller 2001);
- Introverts excelling over extroverts in a videoconference-based learning environment (Offir, Bezalel, and Barth 2007);

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- Online success of reflective and global learners, even though course interactivity should have favored active learners (Mehlenbacher et al. 2000);
- Enhanced problem-solving ability of field-independent learners when aided by visuals (Angeli and Valanides 2004);
- The comfort of convergers and accommodators in online environments. The researchers concluded that students should be able to participate in computer-mediated conferencing as their learning styles require (Fahy and Ally 2005);
- The success of convergers and assimilators in a Web-based, rather than instructor-based, course (Manochehri and Young 2006).

However, other researchers (see, e.g., Ahn and Ahn 2000; DeTure 2004; Dille and Mezack 1991; Ingebritsen and Flickinger 1998; Neuhauser 2002) have not found such relationships between learning style and success in online learning. Although Schellens and Valcke (2000) did not find any relationship between learning style and academic success, they did find that students accommodated their learning styles to different learning environments, a conclusion supported by Aragon, Johnson, and Shaik (2002), whose research demonstrated that appropriate delivery methods can level the field. The conflicting results even within studies reporting a relationship between learning styles and student outcomes should also be noted. For instance, even though Childress and Overbaugh (2001) found no relationship between learning style and final course grade, they did find a relationship between field-independent learners and final-exam performance.

In their study of the variables affecting the outcomes of online courses, Benbunan-Fich and Hiltz (2003) called for research into the relationship between student learning styles, the selection of delivery mode, and student success. Similarly, Allen et al. (2002) proposed providing courses in multiple formats in order to accommodate multiple learning styles. Because a number of studies have already compared the effects of learning styles in online- versus live-course formats (see, e.g., Aragon, Johnson, and Shaik 2002; Manochehri and Young 2006; Neuhauser 2002), I chose a different approach to evaluate the influence of student learning styles in distance education. In addition to studying the general effects of learning styles on course outcomes, I evaluated the influence of collaborative versus self-directed versions and full versus summer sessions. If the relationship between learning style and online delivery mode can be clarified, instructors will be better able to design effective courses, and administrators will be able to provide more useful guidance to prospective online students.

The purpose of this study was to determine the extent to which student learning styles are associated with success in online learning environments, particularly when controlling for the amount of collaboration available to students. Comparisons were made between the success of students enrolled in either of two different versions of an online undergraduate technical

communication course, one a fully collaborative version, the other a self-directed version. Success was measured by several components of students' grades, interactivity with the course software, interaction with classmates, and student satisfaction surveys. Because the nine sections of the course from which data were collected were taught during both 16-week full and 8-week summer sessions, this additional factor was included in the study.

LEARNING STYLES INSTRUMENT

The Index of Learning Styles (ILS) (Felder and Soloman 1991) is a 44-question survey based on a learning style model formulated in 1988 by Richard M. Felder and Linda K. Silverman. It was developed by Felder and Barbara A. Soloman in 1991. The validity and reliability of the index have been verified by a number of studies (see Felder and Spurlin 2005; Litzinger et al. 2007; Zywno 2003).

This particular instrument was chosen for the current study for several reasons. First, because the instrument was created specifically to give insights for use in educational settings (Felder and Silverman 1988), it is appropriate for a study of distance education. Second, it is based on several theories and incorporates other learning style modeling (Moallem 2007). Third, the reporting of learning styles is detailed enough for the coding of student learning style information as categories across four learning scales, which allows the use of categorical data analysis. The index measures students' learning style preferences on four scales, which in turn have two learning dimensions for each scale: active-reflective, sensing-intuitive, visual-verbal, and sequential-global. It also determines whether the respondent has a strong, moderate, or low preference on each of these scales and in which dimension the preference appears. Thus, the scales with their diametrically opposed dimensions may be envisioned as a continuum, for instance, from strong to moderate to low preference along the left side of the scale to low to moderate to strong preference along the right side. Figure 1 shows sample ILS results in which learning preferences for each scale are plotted, giving four learning style measurements for the person evaluated.

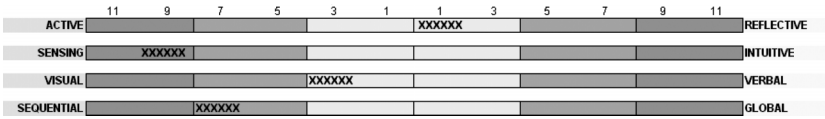

Figure 1. Sample Results From the Index of Learning Styles (ILS). Figure created by John Battalio. ILS Instrument Copyright © 1991, 1994 by North Carolina State University (authored by Richard M. Felder and Barbara A. Soloman).

Of the eight dimensions defined by the index, four of them appear to describe learning styles that are compatible with online learning, which by its nature privileges those who are self-directed, independent, and goal-oriented and would appear to prefer courses that are noncollaborative and independent in nature:

- *Reflective learners*—those preferring to think quietly about information rather than being interactively engaged with persons or learning activities. Unlike active learners who prefer social interaction, reflective learners should theoretically prefer working online because the environment itself favors self-directedness.
- *Intuitive learners*—those preferring discovery, innovation, and abstractions rather than the factual, example-based, concrete learning of sensing learners (see Dille and Mezack 1991). Because of the orientation toward self-directed learning, online students must be the masters of their own learning, even in very organized, instructor-centered courses, by making sense of the variety of materials made available online and integrating these materials into a unified whole. Thus, these learners would be more comfortable managing their own learning.
- *Verbal learners*—those who get more out of words than from visual representations. By its very nature, an online course is reading intensive, and, because students manage their online course through a Web interface or e-mail in-box, reading is an integral part of the online course. Of course, a Web interface does add a significant visual component that may inhibit verbal learners, as shown by Becker and Dwyer (1998). However, twenty-first-century technology has permeated our lives such that today's students, whether visual or verbal learners, should be reasonably comfortable in Internet environments (Battalio 2007).
- *Global learners*—those who learn in large jumps by seeking out the "big picture" rather than learning in the traditional, sequentially organized college course. Theoretically, sequential learners would prefer a live class in which the instructor leads the class through course materials and discussions, whereas global students should be more comfortable filtering through a series of online course materials in order to make the interconnections they need to put their work in perspective.

METHOD

The Online Course

Data were gathered for this study from online versions of English 202 Technical Communication, a three-credit service course. To allow the study of the

influence of the four learning dimensions described above, two versions of English 202 were created using Blackboard:

- A *collaborative version*, in which students collaborated on assignments and were given these assignments on Blackboard on a weekly basis. For short weekly assignments, students worked with different groups for each assignment. For the two longer proposal and report assignments, students were given the option to form their own groups, up to three persons per group. For grouping students into weekly groups and for those students who did not form groups for the longer assignments, I used the random-number function in Microsoft Excel to assign students to preferably three-person groups, four if necessary.
- *A self-directed version*, in which students had access to all assignments at once and completed assignments on their own, although they did work under deadlines for completing assignments. That is, students who did not submit an assignment by a stated deadline did not receive credit for that assignment. While pilot testing this methodology, I learned that such deadlines were necessary to minimize the number of students not completing the course.

Half of the student data come from collaborative sections and half from self-directed sections. Some sections were taught during the regular 16-week semester and some during 8-week summer sessions. Of these sections, 72 students (60%) took the course during the full semester, 48 (40%) during summer sessions. Consequently, it was possible to compare students' learning styles not only with their overall learning success but also with the two types of learning environments as well as summer versus academic year courses in order to determine if one learning environment was more favorable to a specific learning style than another environment.

Coursework consisted of the following assignments, all available on Blackboard: résumé, ethics, instructions, proposal, and report assignments; 12 additional weekly assignments based on textbook readings; quizzes on textbook chapters; and 50-question pre- and posttest examinations, the latter of which was the final exam for the course. All handouts were also available on Blackboard as well as a class e-mail function. The collaborative version also used Blackboard's discussion board for use during collaborative assignments. Here, students posted comments about weekly discussion topics and submitted drafts in progress of their collaborative written assignments. Students were able to work together in other ways, but the majority of their work had to be posted to the discussion board. For each major collaborative assignment, students submitted forms evaluating their group members and explaining in log form their own participation in the assignment. Content for all sections followed the same organization and structure except that, for summer session courses, students began working on the proposal assignment

earlier in the session so that they would have sufficient time to complete the proposal and report assignments.

Student Sample

The data collected for this study came from a convenience sample of students enrolled in nine sections of the course during 2006 and 2007. From these nine sections, usable data were obtained from 120 of these undergraduate students. The university is a metropolitan university with a nontraditional-age student population; consequently, the average age of the students sampled in this study is somewhat higher than the traditional university: 51% were over 26 years of age. Of this group, 30% were 26 to 35; 16% were 36 to 45. The data set contained students from 38 different majors. Of these majors, the largest number (33%) were from engineering programs, 8% from biology, and 7% from English, with the remaining 52% scattered among the remaining 33 majors.

Regarding students' computer experience, all but 9% had previously used Blackboard. A total of 92% considered themselves at least average computer users. The student sample as a whole had varying amounts of experience with Internet communication: 83% said they used e-mail, 50% instant messaging, and 40% Web discussion boards, with smaller numbers of students having used chats, Listservs, Web conferencing, and Internet groups. For 41%, this was their first Internet class. No additional technology training was provided the students.

Information was gathered about students' backgrounds from a demographic survey given at the beginning of the course and from student information available to all instructors as part of the course enrollment process. The survey asked students about their Internet, Blackboard, and general computer experience; current employment status; distance from campus; age range; and reason for taking the course online.

There were no significance differences at the $p < .05$ level in the Internet, courseware, or computer experience; hours of employment; travel distance; age; or grade point averages between students in the sample, whether controlling for version or session. Although the visual-verbal learning scale had significantly more females (Pearson X^2, $d.f. = 1$, $p = .0004$, $n = 120$), this sex bias does not affect the study's conclusions because there were no significant associations between visual-verbal learners. The low 1:3 ratio of verbal-to-visual learners in the sample may have contributed to these results.

Procedures

Instruments. The following three instruments were administered to each student enrolled in the course. Students took these instruments online through Blackboard. Response rates for the two surveys were 93% or above.

1. *Index of Learning Styles* (described previously): The explanatory (independent) variable. This was administered the week prior to the beginning of the course.
2. *Demographic survey*: Given the first week of the course. This 11-question survey obtained information about students' background and experience. Questions dealt with their computer experience, prior experience using Blackboard courseware, Internet usage, knowledge of specific types of technical documents, current employment status, travel distance to campus, and age range. These questions were worded to obtain categorical responses, for instance, travel distance (<30 minutes, 31–60 minutes, etc.), employment status (full-time, part-time, etc.), and so forth. The final question asked students to list their main reason for taking the course online.
3. *End-of-semester course opinion survey*: Given the last week of the semester. This 21-question survey measured student satisfaction with the course by determining the extent to which it met their needs and soliciting opinions about course content and procedures. A four-point Likert scale from *strongly disagree* to *strongly agree* was used.

Measures. Data were collected for the following nine measures, which are the response (dependent) variables.

- *Quiz grade average*: Students took reading quizzes at the completion of each text chapter assignment. These timed quizzes consisted of ten objective questions, such as multiple choice, multiple answer, matching, ordering of information, true/false, and so on. The questions came from a database and were given to students in random order. Quizzes could be taken only once and were graded by Blackboard.
- *Posttest improvement*: As a means of assessing student learning, students were given pre- and posttests on course content. The same test material was given for both tests. However, the questions were given to students in random order each time, and students did not know that they would be retested on the same information at the end of the semester. The test consisted of fifty objective questions in the same question format as described for reading quizzes. Students were given fifty minutes to complete the test, which could be taken only once. The test was also given during the pilot testing of the course and was modified as required.
- *Final exam grade*: The results from the posttest described earlier were used as the students' final exam grade.
- *Semester grade*: Quiz averages, final exam grades, and the grades from the written assignments mentioned earlier under "The Online Course" were the basis of this grade. The two major written assignments, the proposal and formal report, made up 50% of the semester grade.
- *Document quality*: The proposal was used as the writing sample for assessing the quality of student writing because it was one of the two major

writing assignments in the course and its argumentative quality required students to demonstrate more rhetorical skills than required by the other writing assignments in the course. The assessment was based on the following criteria: comprehensiveness in content, evidence, and sourcing; formatting and document design; written clarity and conciseness; factual accuracy and honesty; grammatical and mechanical correctness; and professional appearance. For consistency, a multilevel grading sheet was used. This grading sheet was also available to students on Blackboard when the assignment was made. The learning styles of any of the students were not known until after the course was completed. Each student received a numerical grade for the proposal.

- *Blackboard courseware usage*: Blackboard courseware provides summary and daily statistics for the number of times students access the course site each day, as well as summary and daily statistics for the number of times students access each content, group, and forum area. This data set provides the total number of times each student accessed the course site during the semester.
- *Amount of interaction*: Because there was no collaboration in the self-directed versions, data were collected for the fifty-seven students enrolled in the collaborative version of the course. The amount of interaction for each student is an average of three sources: (1) the percentage of each student's posts to the discussion board. This percentage was based on the average of the number of each student's discussion board posts and the number of his/her group posts as reported by Blackboard; (2) the percentage of his/her visits to the courseware's group area. This percentage was based on the number of times each student accessed the group area as reported by Blackboard; and (3) the percentage of his/her participation in written assignments, which was derived from an average of the total number of hours spent on the proposal and report assignments as self-reported in each student's activity log.
- *Satisfaction*: The following statement from the student opinion survey was used to gauge each student's overall satisfaction with the course: "I am satisfied with my decision to take this course via the Internet." Answers were given on a four-point Likert scale from *strongly disagree* to *strongly agree.*
- *Collaborative preference*: In order to gauge each student's preferences for collaboration, the following statement was included on the opinion survey: "I prefer classes in which I work on my own, rather than interacting with others." Answers were given on a four-point Likert scale from *strongly disagree* to *strongly agree.*

Analysis. Categorical data analysis was performed using SAS, version 9.1. In order to take advantage of the natural ordering in the data, data sets were coded in the following manner:

- For the explanatory (independent) variable, that is, for each of the four learning style dimensions for each student: low, moderate, or strong. This

coding takes advantage of the incremental changes in learning style from the strongest rating on the left end of each scale to the strongest rating on the right end, as shown in Figure 1.

- For the response (dependent) variables:
  - Grade-related data: low, mid, or high;
  - Courseware use and amount of student collaboration: low, mid, or high;
  - Preference data: strongly disagree, disagree, agree, or strongly agree.

The study was interested in the specific relationship between a learning style and a measure; that is, each hypothesis was evaluated with a single test. The specific hypothesis tested was that the subject's learning style was not predictive of that measure. The level of significance was set at 0.0167 to account for the testing of the three learning scales for each measure. As noted above, the initial run showed that there was an insufficient sample of verbal learners to test this learning scale further.

Mantel-Haenszel X^2 statistics are used for reporting individual table results. When controlling for ILS, version, and session, statistics are reported as Row Mean Scores Differ (ANOVA) because of the ordinal nature of the data. In the data sets for three measures (posttest improvement, courseware usage, and document quality), the three response levels were not equally spaced because some data fell below the lowest level cutoff; consequently, modified ridit scores are reported for these three measures. Where table cell sizes were inadequate, Fisher's exact tests were used. Where continuous response variables were available, nonparametric statistics were obtained using Wilcoxon-Mann-Whitney and Kruskal-Wallis tests where applicable. Correlations are reported as Somers's d C|R statistics because the data are ordinal and contain a distinct response variable. Loglinear modeling was not appropriate because the data sets contain a clear response variable (Stokes, Davis, and Koch 2000). Logistic regression was not used because of insufficient sample size.

Measures were obtained of associations for the above contingency table data, that is, for associations between each learning scale (e.g., active vs. reflective) and each of the nine response variables for which data were collected. In addition, because student data were collected from two different versions (collaborative and self-directed) and sessions (full and summer), additional statistics were run to control for these variables. Finally, similar statistics were obtained for each individual learning dimension, that is, active, reflective, sensing, intuitive, and others.

Data were analyzed from a number of perspectives. First, associations were noted between the two dimensions on each of the four learning style scales and the measures studied, for instance, if there was a significant association between the quiz grades of active versus reflective learners. The version in which the student took the course was reviewed to see if quiz grades were significantly different between active and reflective learners depending on

whether they took the collaborative or self-directed version. The same was done for course session. Finally, each learning dimension was studied individually to see if the version students took mattered, that is, if reflective learners taking the self-directed version had significantly higher grades than did reflective learners in the collaborative version.

RESULTS

Reflective learners appear to have been more successful in the online course, and adapted to it better, than any of the other learning dimensions tested. The significant results are summarized below and shown in Table 1.

Reflective learners: Final exams and posttest improvement of reflective students were significantly higher than active learners in one or more of the conditions studied. Reflective learners used course management software and interacted online significantly more than their active counterparts. Most notably, even in the collaborative version, reflectives interacted more than their active counterparts. As expected, reflective learners preferred working alone more than did active learners. This was the case for those taking the full-session and self-directed courses but interestingly not for those in the collaborative version.

Active learners: Significant positive associations among active learners were found only when comparing their performance with active learners in the other version or session. Among active learners themselves, those collaborating had significantly better semester grades than active learners in the self-directed version, but used the software in the self-directed version significantly more than those collaborating. No significant associations were found between active learners and their collaborative preferences.

Sequential learners: Posttest improvement of sequential learners was significantly higher overall than that of global learners and, when controlling for version, was significantly higher in the self-directed version.

DISCUSSION

Given this sample of 120 students, data suggest that learning styles are associated with student success in distance education. Learning style preference may also be a factor in student participation and in student attitudes about their online experience. As shown in Table 1, students with reflective learning styles were the primary beneficiaries of this learning preference.

Noteworthy is that reflective learners taking the full session course did significantly better than active learners on their posttest measure, which was a good indicator of student learning because it measured the difference between students' pre- and posttest exam scores. Reflective learners also preferred

Table 1. Learning Style Associations ($p \leq .0167$)

Associations	Learning scale	Measure	Prob	*d*	ASE	CL 98.33%
By learning scale						
Active vs. reflective[a]		Final exam*	0.0097 (n = 91)	0.4918	0.1385	0.1603–0.8234
Active vs. reflective[a]		Preferred working alone**	< 0.001[b] (n = 113)	0.3805	0.0917	0.1610–0.6000
Sequential[a] vs. global		Posttest improvement*	0.0059 (n = 91)	0.3212	0.1095	0.1066–0.5359
Learning scale by session						
Full	Reflective	Amount of interaction	0.0167[b] (n = 31)	0.4538	0.1680	0.0517–0.8558
Full	Reflective	Posttest improvement	0.0161 (n = 71)	0.3103	0.1212	0.0203–0.6004
Full	Reflective	Preferred working alone**	0.0030[b] (n = 69)	0.4476	0.1146	0.1734–0.7219
Learning scale by version						
Collab	Reflective	Amount of interaction	0.0102 (n = 57)	0.3710	0.1288	0.0627–0.6793
Collab	Reflective	Courseware use*	0.0049 (n = 59)	0.4021	0.1247	0.1037–0.7005
Self-d	Reflective	Preferred working alone**	0.0027[b] (n = 58)	0.5221	0.1149	0.2472–0.7970
Self-d	Sequential	Posttest improvement*	0.0147 (n = 60)	0.3416	0.1314	0.0272–0.6561
Within a learning dimension						
Active: collab		Semester grade	0.0161 (n = 53)	0.3419	0.1380	0.0117–0.6720
Active: self-d		Courseware use*	0.0081 (n = 53)	0.3889	0.1320	0.0730–0.7048

[a]Direction of the association. [b]Fisher's exact test.

*p < .01. **p < .001.

working alone ($p = .0001$). But interestingly, a moderately strong correlation ($d = 0.5221$) was found only for reflective learners taking the self-directed version. Yet these learners interacted significantly more than their active learner counterparts, even in the collaborative version of the course. Reflective learners required to collaborate apparently were able to adapt to that environment as well and were successful academically regardless of version.

Similarly, Mehlenbacher et al. (2000) found that their reflective learners were more successful in their interactive Web environment than were active learners. These results may mirror the observation by Palloff and Pratt (2007) that an online presence may alter one's personality. They suggest, for instance, that introverts may be able to establish social presence more easily online, thus becoming more extroverted; the opposite, in turn, for extroverts. Dille and Mezack (1991, 29) reasoned that internally oriented students "perceive events as contingent upon their own behavior" and thus would be more willing than other learners to persevere in unfavorable circumstances—for instance, in collaborative assignments—in order to achieve success. Two other research studies may provide further insight into these reflective learners' unexpected collaborative efforts. Even though Lee and Lee (2006) found that extroverts interacted significantly more in threaded discussions than introverts, they also suggested that introverts may be prompted to contribute to discussions in which extroverts participate actively. Similarly, Ke and Carr-Chellman (2006) found that their solitary learners valued collaboration for the purpose of sharing perspectives with classmates, but were uncomfortable having to rely on their peers' efforts and time commitments. Perhaps the reflective learners in this study collaborated more in order to compensate for what they believed to be insufficient participation and effort by their active-learner peers.

The only significant associations found for active learners were those in which comparisons were made among themselves, and the results were what one would expect for active learners. Semester grades of active learners in the collaborative version were significantly better than those of these same learners in the self-directed version. Regarding courseware use, active learners in the self-directed version used it significantly more than did these learners collaborating. This result may demonstrate the extent to which active learners rely on their fellow students for information about their courses, referring to class materials only as a last resort, which supports these students' categorization as active learners.

Although Mehlenbacher et al. (2000) found global learners to be more successful online, this study found the opposite. Sequential learners significantly outperformed global learners in posttest improvement ($p < .01$), a good measure of academic performance. Perhaps the course organization and/or software interface may have enabled sequential learners, identified as preferring a traditional, sequentially organized environment, to be successful, reflecting the findings by Aragon, Johnson, and Shaik (2002) of the importance

of delivery method in offsetting learning-style differences. However, that no significant associations favored global learners appears noteworthy.

Finally, that there were no significant associations regarding course satisfaction deserves comment. Particularly given the high level of statistical significance for reflective learners' preference for working alone, one would expect that reflective learners in the self-directed version would be significantly more satisfied than active learners in this version. At the least, one would expect to find significant negative associations among active learners in self-directed versions and reflective learners in collaborative versions. However, students' responses to course satisfaction may not have had as much to do with the course itself as with the fact that the online format satisfied other, perhaps more immediate, personal needs. Students' reasons for taking the course online mirrored those reported in many other studies. Most often mentioned were busy schedule (32%), flexibility (10%), time savings (10%), less travel (9%), and convenience (4%). That the course satisfied these needs perhaps overrode whatever feelings of dissatisfaction that may have been caused by the presentation, content, or outcomes of the course itself.

Felder and Soloman (n.d.) acknowledge that people tend to share at least some of the characteristics of the active, reflective, sensing, and intuitive learning dimensions identified by their index. This sharing may explain the failure of the study to find significant associations between sensing and intuitive learners, but makes the contrast between reflective and active learners even more striking. Even though the other four learning dimensions may not share this kind of interconnection, there are likely to be circumstances, for instance, where global learners having a reflective orientation are more easily able to relate new bits of information to a larger understanding than can global learners with active-learner inclinations. Finding the interconnections among the scales is a more difficult task and one beyond the scope of this study because the data needed to test the interconnections among all eight dimensions would require a much larger student sample.

CONCLUSIONS

The results of this study have shown significant associations between students' learning styles and success in distance education and offer insight into the relationship between learning style and mode of delivery. Considering the numerous associations found between reflective learners and the measures studied, this type of learner appears to be the greatest beneficiary of the online environment. Reflective learners were more successful academically than their active counterparts. Even in the collaborative version, these learners, whose preference for working alone reflects a major characteristic of their learning style, still participated in these collaborative classes

and used the course software significantly more than did active learners. Consequently, it appears that these learners are able to adapt well in either context and thus may be the most successful online learners. It should be noted that, although correlations in the study were in the low to moderate positive range, the number of associations favoring reflective learners supports these conclusions.

Because sequential learners improved significantly more than global learners on their posttest grades, these results may indicate an advantage for these online learners as well, though to a lesser degree than for reflective learners.

There were three instances where significant associations were found in full-session courses. Logically, the more time students have with course materials, the better they will absorb course content, thus enabling them to demonstrate a greater level of learning. The only pattern continued to be the presence of reflective learners in all of these associations, which mirrors the rest of the study's findings. Enrolling in full versus summer session courses does not appear on its own to advantage any of the learning styles tested.

Whatever the association between student learning style and success in distance education, Allen et al. (2002, 92) describe the main issues: (1) identifying students "who work better in a noninteractive or other environment and tailoring the educational procedures to the style that would best serve the student" and (2) determining the appropriate match between the student and the particular instructional format.

Given the results of this study, offering both collaborative and self-directed versions of the same course would appear useful. Active learners made significantly higher semester grades in the collaborative version, whereas reflective learners overwhelmingly preferred working independently. Thus, making available these two versions for each Internet course would seem advantageous, particularly if student satisfaction is a major consideration. However, given the ability of reflective learners to adapt to an interactive environment, a collaborative version would appear to be a reasonable alternative. The additional work required to maintain both iterations would not seem justified for summer session courses given that no significant associations were found.

In concluding their meta-analysis, Allen et al. (2002) pointed out the administrative problems in accommodating learning-style differences because "current diagnostic tools and the implementation of this [diagnosis] as a general procedure and the subsequent effects are currently unknown" (92). The results reported here indicate that a learning-style instrument identifying students' reflective-active and sequential-global preferences would be one such tool in both determining the match between student and instructional format and measuring students' potential success in distance education.

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