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Abstract

For many years, various colleges and universities have found it difficult to measure student satisfaction in online courses. This study examined the growth of math courses that are delivered in the online format. This study looks to address the gaps in the research literature concerning online, hybrid, and traditional education. In particular, it is the intention of this study to investigate satisfaction and its effect on the performance of students as a result of enrolling in online mathematics courses. Many researchers have sought to find ways to determine student satisfaction in online courses. Satisfaction and performance in distance education have always been seen in comparison with traditional education that implements instruction through face-to-face interactions. This study will extend the comparison to include online and hybrid education. An examination of the research literature shows that researchers measure satisfaction and performance in various ways. This situation may well be responsible for the inconsistencies regarding satisfaction and performance found among empirical studies. Although the present study found that older students were not as satisfied in online mathematics courses as younger students, it is not equipped to investigate the reasons driving their lower satisfaction. Future research should look into possible reasons.

Keywords: student satisfaction, online, mathematics courses

With a growing percentage of university students working part-time or full-time and using technology on a more frequent basis in their daily life, colleges and universities are increasingly supplementing their traditional mathematics courses with online equivalents. Online education using the Internet and information technologies is becoming a popular tool for distance education to better meet students' needs, interests, learning styles, and work schedules (Lim, Kim, Chen, & Ryder, 2008). However, published studies are not consistent in comparing performance and satisfaction of students in traditional and online instruction (Lim et al., 2008). Various weaknesses in research are responsible for this inconsistency.

This study aimed to improve the quality of educational research on distance education by filling in some gaps (or overcoming some weaknesses) in the research literature. First, this study developed and validated an instrument that measured students' satisfaction with taking online courses (Tables 1-3). Second, this study explored the relationship among student satisfaction, student performance, and individuals' characteristics, learning preferences, and online (learning) environment (Tables 4-5). Specifically, this study predicted student satisfaction (measured through the developed instrument) from individuals' characteristics, learning preferences, and online (learning) environment (Table 6); and predicted student performance from those same variables plus student satisfaction (measured through the developed instrument) (Table 7). This chapter will explain the methods that were used to accomplish these purposes. As a result, this study contributed to a better measurement of student satisfaction in an online environment. This will hopefully help researchers and practitioners better understand the complex relationship among student satisfaction, student performance, and students' characteristics, learning preferences, and online (learning) environment.

Data Sources

In this study, the target participants were all students who were enrolled in an asynchronous online course, College

Algebra, at a certain Community and Technical College in the Midwest region of the United States (N = 300 students). The students in the online course were of mixed age, gender, and ethnicity. Students were invited to participate in the study and did not receive any compensation for participation. Students were surveyed anonymously. Data on students' characteristics, their learning preferences, and the characteristics of the online (learning) environment were collected in an online survey. Students' viewpoints on personal feedback, perception of online learning, student-student interaction, student-instructor interaction, and social presence in an online course were also collected (using the developed instrument). The researcher also conducted a pretest and posttest of relevant mathematics knowledge and skills.

Instrumentation

The instrument, entitled Satisfaction of Online Learning (SOL), included 24 items embedded in eight components that were developed based on the theoretical framework (see Table 1). The validity of this instrument was established by carefully constructing or selecting items that closely reflect each of the components. The items were developed in this study to isolate certain behaviors that were closely associated with each of the eight factors (components) in Table 1. They were constructed using responses to positive statements. Responsive options for each statement (item) included *Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree* (ranging from 1 to 5 respectively). Students with a higher score indicated more satisfaction to a certain area of a certain factor.

After the construction of the instrument, a pilot was conducted to field-test its functions in the spring of 2013. The instrument was emailed to 15 students in the online course who had one week to work on the instrument. Students were instructed to highlight an option that corresponded most closely to their response to each statement that described a behavior or factor associated with student satisfaction in regards to the online mathematics course. Students were also instructed to answer all items, take notes on anything that caused confusion, and record the time that they needed to complete all items. The result of this pilot served to improve the instrument. The effort helped to answer the first research question: Is it possible to develop a valid and reliable instrument that measures the extent to which students are satisfied with learning mathematics in an online environment?

The formal, comprehensive data collection started in the summer of 2013 with the participation of students in all sections of the asynchronous online course, College Algebra (with consents). At the end of this semester, students were administered (a) SOL, (b) an online survey (measuring individual characteristics, learning preferences, characteristics of online learning environment) (see Appendix B), and (c) a test of mathematics knowledge and skills. To validate SOL, the factorial structure of this instrument was validated through confirmatory factor analysis, and the reliability of this instrument was established by calculating the reliability coefficients of each component and all components as a whole. The online survey used a straightforward design, with questions that collected information about individual characteristics, learning preferences, and online learning environment.

The test of mathematics knowledge and skills covered in the online course (i.e., College Algebra) was given to students within the first two weeks and within the last two weeks of the course so that gains in mathematics knowledge and skills could be measured. The test included multiple choice items and open-ended items, both concerning mathematics knowledge and skills that students learned in the online course (e.g., operations of addition, subtraction, multiplication, and division). Specifically, various aspects of content included mean price, total price, purchase price, rounding, simplifying, combining like terms, ratio, mixed numeral, length, width, angles, and problem solving. This test had been used for many years in the same course, but as an additional check, an experienced mathematician examined the test for the mathematical correctness of the items and the practical appropriateness of the test for the course (i.e., an expert validation process).

Measures and Variables

The online survey had three parts: The first part collected individual data, including gender, age, financial aid (as a measure of socioeconomic status or SES), ethnicity, geographic location, highest mathematics course taken in high school, distance learning experience, working experience, and educational level in college. The second part collected data on students' learning preferences, including visual learning, aural learning, verbal learning, physical learning, logical learning, social learning, and solitary learning. The third part collected characteristics of the online (learning) environment, including instructional format, what time of day to meet, and the delivery method.

The collected data was used to answer the second and third research questions. The second research question concerned whether there is a relationship between student satisfaction in online mathematics courses and individual characteristics, learning preferences, and the online (learning) environment. The third research question concerned whether there was a relationship between students' performance and satisfaction with regard to learning mathematics in an online environment.

For the second research question, the dependent variable was student satisfaction. The independent variables were individual characteristics of students, their learning preferences, and characteristics of the online (learning) environment. Because it was impossible to randomly select participants in this study (i.e., the sample consisted of volunteers), it was important to include student characteristics in the data analysis.

For the third research question, the dependent variable was student performance in the posttest. The independent variables included student performance in the pretest (functioned actually as a covariate), student satisfaction with online mathematics courses, individual characteristics of students, their learning preferences, and characteristics of the online (learning) environment. The data analysis aimed to compare the importance between student satisfaction, students' characteristics, their learning preferences, and characteristics of the online (learning) environment with student performance in the online course.

Statistical Procedures

The statistical procedure for the validation of SOL closely followed the one used in Shen et al. (2012). It begins with an item analysis to make sure that students were using the full range of the responsive options. This task was performed "by examining the frequencies on the responsive options for each statement" (Shen et al., 2012, p. 9). It proceeded to examine the instrument's factorial validity. A series of confirmatory factor analyses were performed to examine whether the eight-factor structure identified through the literature review were present within our sample of online mathematics students. Specifically, the eight-factor model was compared with two other models including the null model and the one-factor model. Comparing the proposed model with the null and one-factor models is a routine procedure in instrument validation (Shen et al., 2012). Model-data-fit statistics included χ^2, SRMR, TLI, CFI, AIC, and BIC (Table 3).

The χ^2 statistic gave an indication of overall fit of the data to the model, with a small χ^2 value indicating a good fit. As one of the absolute measures of fit that does not use an alternative model as the base for comparison, the χ^2 statistic provided only a rough idea about model-data-fit, being quite sensitive to sample size, model size, and variable distribution. The standardized root mean square residual (SRMR) was a much better alternative absolute index. An SRMR value smaller than .08 is considered a good fit (see Hu & Bentler, 1999). The comparative fit index (CFI) and the Tucker-Lewis index (TLI) could be considered as relative measures of fit because they used an alternative model as the basis for comparison. CFI avoids the underestimation of the model-data-fit, often occurring when a sample is small. TLI provids a measure of model-data-fit that is independent of sample size. Because both CFI and TLI measured the proportion of variance explained in relation to the null model, a value greater than .90 indicates a good fit (see Hu & Bentler, 1999). Lastly, because the models in this study were non-nested ones, information-based estimates were also used to evaluate goodness of fit, including Akaike information criterion (AIC) and Bayesian information criterion (BIC). A best-fitting model had the smallest estimate on both AIC and BIC.

Once the factorial structure was "empirically supported, we combined items within each scale in order to produce the mean and standard deviations for each scale" and this task was "performed by taking the average of valid responses within each scale" (Shen et al., 2012, p. 14-15). Distribution of scale scores were then examined with "two distribution indices: *skewness*, to make sure that scores were roughly symmetrical around the mean; and *kurtosis*, to make sure that the distributions were not overly peaked or overly flat" (Shen et al., 2012, p. 15) (Table 4). Finally, Cronbach's alpha was used as the measure of internal consistency. Reliability analysis was performed on each scale and the instrument as a whole (see Shen et al., 2012) (Table 5). This statistical procedure concluded statistical analysis of the first research question.

For the second research question, a multiple regression analysis was performed with student satisfaction as the dependent variable and variables descriptive of individual characteristics, learning preferences, and online (learning) environment as the independent variables (Table 6). After handling missing data on the dependent variable (i.e., SOL), N = 102 students remained for data analysis. For the third research question, a multiple regression analysis was performed, with student posttest performance as the dependent variable and student pretest performance as a measure of prior ability (a covariate by nature) (Table 7). The independent variables were the same as those used in addressing the second research question (i.e., variables descriptive of individuals' characteristics, learning preferences, and the online learning environment). After handling missing data on the dependent variable (i.e., posttest), N = 68 students remained for data analysis.

Because the sample size was relatively small in the case of both research questions, independent variables were first examined individually to test their absolute effects. The absolute effects of a variable refer to the effects of that variable that will occur without the presence of other variables in the statistical model. Variables that are found to have absolute effects are then tested together in the statistical model to see if relative effects appear. The relative effects of a variable refer to the effects of that variable that will occur in the presence of other variables in the statistical model. This strategy successfully avoided entering a large number of independent variables together into the regression model (the so-called stepwise approach that is not a sound statistical practice when the regression model runs on a small sample).

Specification and Validity of SOL Items

The validity of SOL was established by carefully constructing each item based on empirical evidence or references. That is, empirical evidence or references functioned to provide clues for the wording or description of each item. Each piece of evidence or each reference served as a foundation for the construction of each item in SOL. This approach helped to validate the instrument (SOL) with stronger proof and greater clarity. Table 2 presents the specifications and validations of SOL items in detail.

Summary of Principal Findings

The instrument, Satisfaction of Online Learning (SOL), was found to be highly valid and highly reliable. Specifically, both item analysis and scale analysis did not show any abnormal distributional properties of SOL. According to the common comparative practice in confirmatory factor analysis, the eight-factor model represented substantial improvement in model-data-fit over the null model and the one-factor model. Reliability analysis indicated substantially high internal consistency across scales and as a whole instrument.

Multiple regression analysis was performed using students' satisfaction with online mathematics courses as the dependent variable and variables descriptive of individual characteristics, learning preferences, and the online (learning) environment as the independent variables. All of the independent variables were tested for absolute effects and relative effects. Overall, age demonstrated both absolute effects and relative effects and was considered robustly important to student satisfaction. Younger students were more satisfied with online mathematics courses than older students. Pre-calculus/calculus (vs below pre-calculus) and visual learning showed absolute effects but not relative effects, and were thus considered unimportant to student satisfaction. All other variables did not even show absolute effects on student satisfaction. Therefore, students' satisfaction was related only to their age.

Multiple regression analysis was also performed with posttest scores as the dependent variable, pretest scores as the covariate, and variables descriptive of individual characteristics, learning preferences, online (learning) environment, and satisfaction with online mathematics courses as the independent variables. None of the independent variables showed absolute effects. Therefore, gains in mathematics knowledge and skills from pretest to posttest in the course were not related to individual characteristics, learning preferences, or the online (learning) environment. Neither were gains related to satisfaction with online mathematics courses.

In sum, SOL as an instrument filled in a significant gap in the research literature for measuring students' satisfaction with online mathematics courses. It provides a valid and reliable alternative evaluation to traditional course evaluation for colleges and universities to determine student satisfaction in their online courses. Although this study attempted to determine the effects of variables that describe individual characteristics, learning preferences, and the online (learning) environment on student satisfaction, age was the only significant factor separating student satisfaction. Lastly, this study aimed to examine the relationship between student performance and satisfaction in an online environment. However, students' gains in mathematics knowledge and skills were not related to their satisfaction (nor to individual characteristics, learning preferences, and the online environment).

Revisiting Research Literature

The present study took the position that IT (information technology) does not bring about a new learning culture independent of pedagogical settings (Blömeke, Muller, & Eichler, 2006; Schulz-Zander, 2005; Tergan, 2003; Vovides, Sanchez-Alonso, Mitropoulou, & Nickmans, 2007). Instead, there is a strong need to describe adequate settings of learning and instruction for all kinds of e-learning (Giest, 2010). The present study attempted to understand the pedagogical settings from three essential aspects (characteristics of individuals, learning preferences, and online environment) that may associate with performance and satisfaction in the online learning of mathematics.

Online Environment

A vehement argument has long been waged, pitting distance education against traditional face-to-face education (Tucker, 2001). There are arguments in the research literature that support the "superiority" of alternative instructional environments. For example, Kendall (2001) asserted that online courses can achieve learning goals and student satisfaction as much as, if not more than, traditional courses. After comparing these three different learning environments, Lim et al. (2008) reported that students in the online learning group and the hybrid learning group have statistically significant higher levels of achievement than students in the traditional learning group and students in the hybrid learning group also have greater satisfaction levels with their overall learning experience than students in the traditional group.

There are also arguments in the research literature that support the "inferiority" of alternative instructional environments. For example, Faux and Black-Hughes (2000) found the largest improvement in performance (from pretest to posttest) for students in the traditional face-to-face environment. Students who prefer traditional environment show a stronger mastery goal orientation and greater willingness to apply effort while learning than students who prefer either online or hybrid environments (Clayton et al., 2010).

The present study did not have separate groups in various online environments; instead, preferences for online learning environments were compared in relation to student performance and satisfaction in the online learning of mathematics. In other words, the present study focused on student preferences for online learning environment (i.e., online vs face-to-face, hybrid vs face-to-face). The results of the present study indicated that students who preferred hybrid instructions were as satisfied with their online learning experiences in mathematics as students who preferred traditional instructions. Meanwhile, students who preferred hybrid instructions gained as much in mathematics knowledge and skills in the course as students who preferred traditional instructions. These conclusions hold true to the comparisons between online instructions and traditional instructions. That is, students who preferred online instructions were as satisfied with their online learning experiences in mathematics as students who preferred traditional instructions, and students who preferred online instructions gained as much in mathematics knowledge and skills in the course as students who preferred traditional instructions. Based on the above findings, this study could not support either the superiority or inferiority of both hybrid instructions and online instructions over traditional instructions from the perspectives of student performance and satisfaction in the online environment of learning mathematics. In particular, the pretest and posttest design of the present study added important insights into the research literature because comparisons based on the longitudinal perspective have been rather rare in the research literature.

Individual Characteristics

The limited research literature on individual differences in online learning focuses mainly on age and gender differences. Previous research indicated significant gender differences in performance, attitudes, motivation, and experiences (Ashby, Sadera, & McNary, 2011; Branden & Lambert, 1999; Chen, 1999; Muilenberg & Berge, 2005; Owens, 1998). Previous research also found age to be a significant factor for learning (educational) outcomes in online courses (Ashby et al., 2011; Muilenberg & Berge, 2005; Rekkedal, 1983).

In the present study, age was found to be robustly important to satisfaction with online mathematics courses but unimportant to performance in online mathematics courses. Furthermore, gender differences were not found in either performance or satisfaction concerning the online learning of mathematics. These findings all represent new contributions to the field of online mathematics education. In particular, Thurmond, Wambach, Connors, and Frey (2002) asserted that student satisfaction is influenced by instructional decisions and actions in the online environment but not by student characteristics. The present study suggests that certain individual characteristics (e.g., age) may still have influence on student satisfaction.

Learning Preferences

The research literature on online education contains some information on what learning preferences (styles) fit better to the online learning environment such as active vs reflective, sensing vs intuitive, visual vs verbal, and sequential vs global (Kim & Moore, 2005). Schellens and Valcke (2000) noticed that developers of online courses tend to favor visual, applied, spatial, social, and creative styles of learning. Nevertheless, how learning preferences relate to performance and satisfaction remains an under-research issue, which partially motivated the present study.

There are conflicting results regarding whether learning preferences (styles) relate to academic performance (Fahy & Ally, 2005). Some studies on online learning suggest that students' learning preferences are associated with their course performance (Douzenis, 1999; Sabry & Baldwin, 2003; Terrell, 2002). Meyer (2003) argued that visual learners are more academically successful than aural and kinesthetic learners in an online learning environment (see also Ozbas, 2008 for gender differences in academic performance in an online learning environment that emphasizes visual learning). On the other hand, Santo (2001, 2006) found no relationship of learning preferences to both course grades and test scores.

According to Henry (2008), the visual-verbal dimension of students' learning preferences (styles) correlates positively with satisfaction as learners in a hybrid (e-blended) course delivery mode but negatively with satisfaction as learners in a traditional course delivery mode. Overall, however, Kearsley (2000) indicated no relationship between students' learning preferences and their satisfaction with online courses.

The present study provided some further insights into the relationship of learning preferences to performance and satisfaction in the online learning environment. Specifically, learning preferences were related to performance and satisfaction in the online learning of mathematics. Confidence is high in the present study in that satisfaction was measured with a validated instrument and performance was measured in a pretest and posttest design. These features of the present study are rather rare in the research literature. In this sense, the present study has contributed unique insights into the research literature.

Relationship between Performance and Satisfaction

Currently, the research literature on this issue is very "thin" from the perspective of online education, even though performance and satisfaction in online collaborative learning are important factors to determine whether an innovative learning approach can be applied in a sustainable way (Zhu, 2012). Inferences can be drawn from some studies indirectly examining the relationship. Although students in the face-to-face format achieve higher on both exams and course grades than students in the online format, students' satisfaction do not differ between the two formats (Driscoll et al., 2012). These studies seem to suggest a lack of relationship between performance and satisfaction. Yatrakis and Simon (2002) directly rejected the relationship. On the other hand, learner satisfaction is a significant predictor of learning outcomes (Eom, Wen, & Ashill, 2006).

The present study explored the relationship between performance and satisfaction in the online learning of mathematics. Satisfaction was not a significant predictor of performance. Again, confidence is high in the present study due to the fact that satisfaction was measured with a strictly validated instrument and performance measure came from in a rigid pretest and posttest design. These features of the present study are rather uncommon in the research literature, permitting the present study to make unique contributions to the current understanding of the relationship between performance and satisfaction.

Implications

Instrument Application

Kane, Williams, and Cappuccini (2008) argued that student institutional satisfaction surveys are a valuable source of data for instructional improvement but little has been used outside their immediate management improvement purposes. Meanwhile, researchers have commonly used a single-item rating scale to assess student satisfaction, but this approach fails to recognize the complexity of students' reactions to educational service (Elliott & Shin, 2002). The instrument (SOL) that has been validated in the present study can help improve both situations in that SOL is a great tool to generate specific information on many aspects of student institutional satisfaction that can be easily applied to instruction as well as management of online courses. All of the eight scales within the instrument can be used either individually or collectively to measure student satisfaction for various purposes of instruction and management.

Age Factor

The present study found that older students tended to be less satisfied with online mathematics courses than younger students. This finding may serve as a call for instructors to be more attentive to the way that they communicate information to older students in an online classroom. Moore (1993) suggested that for distance learning to be successful, instructors need to pay attention to three elements of transactional distance theory (dialogue, structure, and learner autonomy) in order to reduce the “distance” experienced by students. When distance is felt by students in the online course, they tend to feel isolated and may stop participating in the subsequent learning activities. The best way to reduce distance is to structure the course in such a way that all learners (both young and old) can benefit from the material that is presented in the online mathematics course. According to Chao and Davis (2001), there are many facets to the online success of math courses such as paying attention to the design and utilization of effective online pedagogy, maintaining active communication between students and the instructor, encouraging interaction between students in the classroom, and using computer programs like Excel as a way to illustrate statistical concepts in the classroom.

In addition, it is important to identify characteristics of students who feel successful with their online learning experiences so as to provide necessary information for instructors and admission officers to either encourage or discourage a student from registering for an online course (Wojciechowski & Palmer, 2005). The present study, in this sense, is useful to administrations at colleges and universities. Younger students are more likely to be satisfied with taking mathematics courses in the online environment than older students can become a factor to aid decision making.

Limitations

Sampling-related issues represent the major limitations of the present study. The initial sample size of 259 students was promising, but the three separate data collection procedures (SOL; online survey of individual characteristics, learning preferences, and online environment; mathematics test in pretest and posttest format) produced missing data. As a result, the confirmatory factor analysis was based on 123 students with valid SOL scores. Confirmatory factor analysis based on such a sample size is less ideal (see Shen et al., 2012). Missing data reduced sample size again when it came to answering the second and third research questions. Multiple regression analysis to address the second research question was based on 102 students, and that to address the third research question was based on 68 students. Although the strategy of examining absolute effects individually first is effective and sufficient analytically, results regarding the second and third research questions need to be considered tentative. Due to the limited number of online students that can often be reached in any study, it is suggested that future researchers accumulate data from different semesters to improve the number of student responses (Kuo, 2010).

The use of volunteer sample represents another major limitation. Although the difficulty in obtaining a random sample is adequately realized in educational research, a large number of studies based on volunteer samples need to be conducted for any meaningful synthesis of results across studies. It is suggested that future researchers continue this line of research with various volunteer samples if random sampling is impractical. Indeed, several researchers have suggested that more research be done to collectively deal with the lack of large random samples concerning online learning (e.g., Ertmer et al., 2007; Kuo, 2010; Richardson, 2005).

The scope of the present study was limited. The part of the online survey that collected information on individual characteristics was not as comprehensive as one would like. For example, Dabbagh (2007) found that intrinsically motivated learners with a positive attitude toward the instructor and a high expectation for grades and degree completion are more likely to succeed in a distance education course. The space limitation prevented the present study to look into whether students' attitude and expectation can predict performance and satisfaction in the online learning of mathematics. This issue leaves sufficient opportunities for future researchers.

Recommendations for Further Research

Although some recommendations for further research have been offered in the previous section, more discussion on this line of research may be beneficial. SOL is a valid and reliable instrument, but nevertheless it was developed based on a particular college-level mathematics course (i.e., College Algebra). Therefore, this instrument needs to be validated and even modified within and beyond the area of mathematics education. For example, SOL can be validated for more advanced mathematics courses taught in an online environment; and SOL can also be validated for college science courses. Although it is reasonable based on the review of research literature to expect SOL to be a general measure of satisfaction with any online courses, further validation is necessary.

Because of the tentative nature of the results from multiple regression analyses, there is a need for future researchers to replicate studies concerning the comprehensive relationship among student performance and satisfaction in online learning of mathematics as well as individual characteristics, learning preferences, and online (learning) environment. Following a similar logic, further studies may include different variables descriptive of individual characteristics, learning preferences, and online (learning) environment.

Although the present study found that older students were not as satisfied in online mathematics courses as younger students, it is not equipped to investigate the reasons why they are less satisfied. Future research can look into possible reasons. Some research may even focus on older students and their reasons for taking math courses online. As a result, future online courses can be built with more resources and help so that their time in the online environment may become a good experience.

References

Ashby, J., Sadera, W. A., McNary, S. W. (2011). Comparing student success between developmental math courses offered online, blended, and face-to-face. *Journal of Interactive Online Learning*, *10*(3), 128-140.

Blömeke, S., Müller, C., & Eichler, D. (2006). Unterricht mit digitalen Medien – zwischen Innovation und Tradition? *Zeitschrift für Erziehungswissenschaft*, *9*(4), 632-650. http://dx.doi.org/10.1007/s11618-006-0172-3

Branden, J. B., & Lambert, J. (1999). Cultural issues related to transactional open and distance learning in universities: A European problem? British Journal of Educational Technology, 30(3), 251-260.

Chao, F., & Davis, J. (2001). Student Satisfaction with Online Math Courses and Its Impact on Enrollments. In J. Price, D. Willis, N. Davis, & J. Willis (Eds.), *Proceedings of Society for Information Technology &*

Teacher Education International Conference 2001 (pp. 1348-1349). Chesapeake, VA: Association for the Advancement of Computing in Education (AACE).

Chen, A. E. A. (1999). Cultural issues in the design of technology-enhanced learning systems. *British Journal of Educational Technology*, *30*(3), 217-230.

Clayton, K., Blumberg, F., & Auld, D. (2010). The relationship between motivation, learning strategies, and choice of environment whether traditional or including an online component. *British Journal of Education Technology*, *41*(3), 349-364. doi:10.1111/j.1467-8535.2009.00993.x

Dabbagh, N. (2007). The online learner: Characteristics and pedagogical implications. *Contemporary Issues in Technology and Teacher Education*, *7*(3), 217- 226.

Douzenis, C. (1999). *The relationship between cognitive style and achievement in a distance education course*. Paper presented at the Annual Meeting of the American Educational Research Association, Montreal, 1999.

Driscoll, A., Jicha, K., Hunt, A. N., Tichavsky, L., & Thompson, G. (2012). Can online courses deliver in-class results? A comparison of student performance and satisfaction in an online versus a face-to-face introductory sociology course, *Teaching Sociology*, *40*(4), 312-331.

Elliott, K. M., & Shin, D. (2002). Student Satisfaction: An alternative approach to assessing this important concept. *Journal of Higher Education Policy and Management*, *24*(2), 197-209.

Eom, S., Wen, J., & Ashill, N. (2006). The determinants of students perceived learning outcomes and satisfaction in university online education: An empirical investigation. *Journal of Innovative Education*, *4*(2), 1-4.

Ertmer, P. A., Richardson, J. C., Belland, B., Camin, D., Connolly, P., Coulthard, G., Lei, K., & Mong, C. (2007). Using peer feedback to enhance the quality of student online postings: An exploratory study. *The Journal of Computer-Mediated Communication*, 12(2), 412-433.

Fahy, P. J., & Ally, M. (2005). Student learning style and asynchronous computer-mediated conferencing (CMC) interaction. *The American Journal of Distance Education*, *19*(1), 5-22.

Faux, T. L., & Black-Hughes, C. (2000). A comparison of using the Internet versus lectures to teach social work history. *Research on Social Work Practice*, *10*(4), 454-466.

Giest, H. (2010). Reinventing Education: New technology does not guarantee a new learning culture. *E-Learning and Digital Media*, *7*(4), 366-376.

Henry, P. (2008). Learning style and learner satisfaction in a course delivery context. *International Journal of Humanities and Social Sciences*, *2*, 71.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*(1), 1-55.

Kane, D., Williams, J., & Cappuccini, G. (2008). Student satisfaction surveys: The value in taking an historical perspective. *Quality in Higher Education*, *14*(2), 137–158.

Kearsley, G. (2000). *Online education: Learning and teaching in cyberspace* (Vol. 91). Belmont, CA: Wadsworth.

Kendall, M. (2001). Teaching online to campus-based students: The experience of using WebCT for the community information module at Manchester Metropolitan University. *Education for Information*, *19*(4) 325-346.

Kim, K. S., & Moore, J. (2005). Web-based learning: Factors affecting students' satisfaction and learning experience. *First Monday*, *10*(11). Retrieved from http://www.ojphi.org/ojs/index.php/fm/article/view/1294/1214

Kuo, Y. (2010). *Interaction, Internet self-efficacy, and self-regulated learning as predictors of student satisfaction in distance education courses* (Doctoral Dissertation). Retrieved from http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1737&context=etd

Lim, J., Kim, M., Chen, S., & Ryder, C. (2008). An empirical investigation of student achievement and satisfaction in different learning environments. *Journal of Instructional Psychology*, *35*(2), 113-119.

Meyer, K. A. (2003). The web's impact on student learning. *THE Journal*, *30*(10). Retrieved from http://www.editlib.org/p/97482

Moore, M. G. (1993). Theory of transactional distance. In D. Keegan (Ed.), *Theoretical principles of distance education* (pp. 22-38). New York, NY: Routledge.

Muilenberg, L. Y., & Berge, Z. L. (2005). Student barriers to online learning: A factor analytic study. *Distance Education*, *26*(1), 29-48.

Owens, E. W. (1998). Sex and ethnic relates differences amongst high school students' technology use in science and mathematics. *International Journal of Instructional Media*, *25*(1), 43-55.

Ozbas, S. (2008). The investigation of the learning styles of university students. *The Online Journal of New Horizons in Education*, *3*(1), 53-58.

Rekkedal, T. (1983). Enhancing student progress in Norway: The Open University. *Teaching at a Distance*, *23*, 19-24.

Richardson, J. T. E. (2005) Students' perceptions of academic quality and approaches to studying in distance education. *British Educational Research Journal*, *31*(1), 1-21.

Sabry, K., & Baldwin, L. (2003). Web-based learning interaction and learning styles. *British Journal of Educational Technology*, *34*(4), 443-454.

Santo, S. A. (2001). *Virtual learning, personality, and learning styles* (Unpublished doctoral dissertation). University of Virginia, Charlottesville, Virginia.

Santo, S. (2006). Relationships between learning styles and online learning: Myth or reality? *Performance Improvement Quarterly*, *19*(3), 73-88.

Schellens, T., & Valcke, M. (2000). Re-engineering conventional university education: Implications for students' learning styles. *Distance Education*, *21*(2), 361-384.

Schulz-Zander, R. (Ed.) (2005). Lernwege suchen. *Computer & Unterricht*, *15*(57), 6-10.

Shen, J., Cooley, V., Ma, X., Reeves, P., Burt, W., Rainey, J. M., & Yuan, W. (2012). Data-informed decision-making on high-impact strategies: An instrument for improving principalship. In J. Shen (Ed.), *Tools for improving school principal's work* (pp. 107-135). New York, NY: Peter Lang.

Tergan, S. O. (2003). Lernen und Wissensmanagement mit Hypermedien. *Unterrichtswissenschaft*, *31*(4), 334-358.

Terrell, S. R. (2002). The effect of learning style on doctoral course completion in a Web-based learning environment. *Internet and Higher Education*, *5*(1), 345-352.

Thurmond, V., Wambach, K., Connors, H. R., & Frey, B. B. (2002). Evaluation of student satisfaction: Determining the impact of a web-based environment by controlling for student characteristics. *The American Journal of Distance Education*, *16*(1), 169-190.

Tucker, S. (2001). Distance Education: Better, Worse, Or As Good As Traditional Education? *Online Journal of Distance Learning Administration*, *4*(4), 1-6.

Vovides, Y., Sanchez-Alonso, S., Mitropoulou, V., & Nickmans, G. (2007). The Use of E-learning Course Management Systems to Support Learning Strategies and to Improve Self-Regulated Learning. *Educational Research Review*, *2*(1), 64-74. http://dx.doi.org/10.1016/j.edurev.2007.02.004

Wojciechowski, A., & Palmer, L. B. (2005). Individual student characteristics: Can any be predictors of success in online classes? *Online Journal of Distance Learning Administration*, *8*(2). Retrieved from http://www.westga.edu/%7Edistance/ojdla/summer82/wojciechowski82.htm

Zhu, C. (2012). Student satisfaction, performance, and knowledge construction in online collaborative learning. *Educational Technology & Society*, *15*(1), 127-136.

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Table 1
Foundation for Instrument Development

Factor	Item
Effectiveness of feedback	1-3
Timeliness of feedback	4-6
Use of discussion boards in the classroom	7-9
Dialogue between instructors and students	10-12
Perception of online experiences	13-15
Instructor characteristics	16-18
Feeling of a learning community	19-21
Computer-mediated communication	22-24

Table 2
Distribution of Responses and Descriptive Statistics across Items

Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
Q1	.10	.05	.19	.35	.32	3.74	1.23
Q2	.11	.04	.18	.33	.34	3.76	1.26
Q3	.10	.05	.20	.34	.31	3.72	1.23
Q4	.11	.02	.19	.34	.35	3.81	1.23
Q5	.12	.02	.17	.29	.40	3.83	1.31
Q6	.09	.05	.22	.34	.30	3.70	1.20
Q7	.08	.12	.37	.21	.21	3.35	1.18
Q8	.09	.08	.28	.28	.27	3.55	1.22
Q9	.09	.09	.22	.33	.27	3.60	1.22
Q10	.10	.03	.23	.28	.37	3.78	1.25
Q11	.10	.06	.24	.32	.29	3.65	1.23
Q12	.10	.05	.30	.28	.28	3.59	1.22
Q13	.08	.07	.25	.32	.28	3.66	1.19
Q14	.09	.07	.19	.37	.28	3.68	1.21
Q15	.13	.08	.27	.19	.33	3.51	1.37
Q16	.12	.09	.26	.24	.28	3.48	1.32
Q17	.12	.09	.27	.25	.26	3.44	1.30

Q18	.11	.11	.31	.19	.28	3.40	1.31
Q19	.15	.10	.30	.23	.23	3.29	1.32
Q20	.14	.14	.30	.22	.20	3.21	1.30
Q21	.11	.09	.34	.21	.24	3.38	1.26
Q22	.12	.08	.35	.22	.22	3.35	1.26
Q23	.15	.15	.34	.18	.19	3.11	1.29
Q24	.12	.16	.32	.20	.20	3.19	1.27

Note. Values other than means and SDs represent percentages.

Table 3
Results of Model Data Fit from Confirmatory Factor Analysis

Model	X^2	CFI	TLI	SRMR	AIC	BIC
Null factor	5052.41					
1 factor	1474.15	0.74	0.72	0.06	6277.32	6479.80
8 factor	590.71	0.92	0.90	0.05	5449.88	5731.10

Table 4
Descriptive Statistics across Scales

Scale	Mean	SD	Skewness	Kurtosis
Effectiveness of Feedback	3.74	1.24	-0.92	0.01
Timeliness of Feedback	3.78	1.25	-0.99	0.15
Use of Discussion Boards	3.50	1.21	-0.54	-0.49
Dialogue between instructors and students	3.67	1.23	-0.77	-0.19
Perceptions of online experiences	3.62	1.26	-0.69	-0.40
Instructor characteristics	3.44	1.31	-0.44	-0.81
Feeling of a learning community	3.29	1.30	-0.31	-0.85
Computer-mediated communication	3.22	1.27	-0.20	-0.83

Table 5
Reliability Statistics across Scales

Scales	Number of Items	Reliabilities
Effectiveness of Feedback	3	0.98

Timeliness of Feedback	3	0.98
Use of Discussion Boards	3	0.98
Dialogue between instructors and students	3	0.98
Perceptions of online experiences	3	0.98
Instructor characteristics	3	0.98
Feeling of a learning community	3	0.98
Computer-mediated communication	3	0.98
Instrument as a whole	24	0.98

Table 6
Multiple Regression Results Estimating Effects of Individual Characteristics, Learning Preferences, and Online Environment on Satisfactory with Online Mathematics Courses

Variables	Absolute Effect	SE	Relative Effect	SE
Individual characteristics				
Age (continuous)	-.87*	.24	-.59*	.28
Male (vs female)	-2.9	6.21		
White (vs non-White)	3.20	8.02		
Pre-calculus/calculus (vs below pre-calculus)	16.37*	8.11	15.84	8.80
Up to associate degree (vs high school diploma)	.40	5.89		
Bachelor and beyond (vs high school diploma)	-13.19	6.94		
Financial aid (vs no financial aid)	-7.26	7.98		
Years of working experience (continuous)	-.55	.61		
Number of online courses (continuous)	.24	2.18		
Learning preferences				
Visual learning (continuous)	4.98*	2.41	3.51	2.65
Aural learning (continuous)	-1.26	2.97		
Verbal learning (continuous)	3.31	2.75		
Physical learning (continuous)	2.32	2.56		
Logical learning (continuous)	2.89	2.69		
Social learning (continuous)	3.94	2.92		
Solitary learning (continuous)	-2.93	2.79		
Online environment				
Preference on online (vs face-to-face)	9.67	6.72		

Preference on hybrid (vs face-to-face)	6.92	8.31
Scheduled sessions (vs non-scheduled sessions)	-6.18	6.78
Asynchronous (vs synchronous)	3.72	5.84

* $p < .05$.

Table 7

Multiple Regression Results Estimating Effects of Individual Characteristics, Learning Preferences, Online Environment, and Satisfactory with Online Mathematics Courses on Gains in Mathematics Performance

Variables	Absolute Effect	SE
Individual characteristics		
Age (continuous)	.03	.04
Male (vs female)	.71	.65
White (vs non-White)	1.29	.86
Pre-calculus/calculus (vs below pre-calculus)	.163	.75
Up to associate degree (vs high school diploma)	-.12	.61
Bachelor and beyond (vs high school diploma)	.55	.65
Financial aid (vs no financial aid)	1.30	.86
Years of working experience (continuous)	.01	.08
Number of online courses (continuous)	.39	.26
Learning preferences		
Visual learning (continuous)	-.20	.23
Aural learning (continuous)	-.01	.33
Verbal learning (continuous)	-.31	.30
Physical learning (continuous)	-.07	.25
Logical learning (continuous)	-.03	.26
Social learning (continuous)	-.10	.29
Solitary learning (continuous)	-.19	.30
Online environment		
Preference on online (vs face-to-face)	.19	.80
Preference on hybrid (vs face-to-face)	-1.15	1.18
Scheduled sessions (vs non-scheduled sessions)	-.55	.88

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Asynchronous (vs synchronous)	-.43	.61
Satisfactory with Online Mathematics Courses	-.02	.01

* $p < .05$