



Effects of Learning Style on Paper Versus Computer Based Reading Comprehension

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The test mode effect states that when an identical test is given on paper and a computer, the results obtained will be different depending on the medium the test is presented on. This effect and the reality that the number of online courses being offered is steadily increasing has implications for what types of students should be taking classes online. The purpose of this study is to determine if learning style has an influence on the success of paper-based versus computer-based comprehension on tests. A group of 67 participants in lower level psychology courses completed the Gregorc Style Delineator and performed a reading comprehension test on paper or a computer. It was hypothesized that students scoring high as Concrete Sequential will do best on paper while students performing high as Abstract Random will do best on a computer. However, there was no significant impact on the number of errors made when compared to the learning style or the media the test was presented on.

Within the last two decades, the amount of courses being offered online has been increasing. There has also been a steady increase for students enrolling in these courses (Collins, 2009). Universities are beginning to increase the amount of online courses to reach more students because of the flexibility learning online offers to students (Thirunarayanan & Perez-Prado, 2001-2002; Dutton, Dutton, & Perry, 2001). The dynamics of online courses are changing, incorporating more learning styles than the typical independent learners thought of previously. Increased communication tools are being used to promote the presence of students in the virtual environment (Brown, 2011).

Clariana and Wallace (2002) discovered the test mode effect that states, when comparing two identical tests one given on paper and one on a computer you will obtain different results. The chance of getting

equivalent results is only 50%. They found, on average, paper-based test scores are higher than the equivalent computer-based tests. The question that arises from this effect is what causes the difference in scores.

There are many factors to consider when determining the cause of the test mode effect. The first is attrition; online courses have more students dropping out than traditional students (Zacharias, 2010). Completion rates vary greatly with traditional students completing the course at 93.6% while online students only complete the course at 79.4% (Dutton, Dutton, & Perry, 2001). This could mean that there is a difference in the types of students that take online courses or how the course is designed. Students who drop out may drop out because the online class is too confusing or difficult for them to be successful.

Noyes, Garland, and Robbins (2004) found that online material requires more effort





than paper-based material. They found that the cognitive workload was higher in the online groups. The research found that there was more perceived effort to read and comprehend on the computer-based comprehension. Their research also stated that those who had the lowest comprehension scores also had the greatest workload stress. Students also become more fatigued when reading from text on a computer screen than when they read identical text on paper (Clariana & Wallace, 2002). When testing on computers, the time between reading the text and scrolling down to the answers increases transition time and memory between each question (Clariana & Wallace, 2002; Bodmann & Robinson, 2004).

Other factors that have been considered in past research studies include content familiarity, gender, and age. Clariana and Wallace (2002) found that the class content familiarity produces significant results in paper-based versus computer-based assessments. Computer familiarity has also been studied but no significant difference was found on assessments (Clariana & Wallace, 2002; Cicco, 2009; Zacharias, 2010). Gender has also been studied extensively with no significant difference in the assessment scores (Diaz & Cartnal, 2009; Neuhauser, 2002). The age of students (whether they are traditional college age) has shown no significant effects on score (Diaz & Cartnal, 1999; Neuhauser, 2002). Finally, learning preference and style have begun to be investigated (Cicco, 2009; Collins, 2009; Brown, 2011; Neuhauser, 2002; Diaz & Cartnal, 1999; Zacharias, 2010).

Learning styles are personal qualities like attentiveness and motivation that influence a student's ability to acquire information, to interact with peers and the teacher and otherwise to participate in learning experiences (Diaz & Cartnal, 1999). These learning styles are consistent over time and do not vary in different areas of learning (Miller, 2005). The learning style gives students a way

to internalize, process, and remember information (Collins, 2009). Different learning style inventories have been developed to determine a learning style the best suits the learner. Learning styles may be one of the causes of the difference in test scores on paper-based versus computer-based assessments.

Previous studies have investigated common characteristics thought to be held by online learners. A study by Brown (2011) proposed that independent learners would do the best in online courses. Independent learners are confident in their learning abilities and can control their learning. They can complete work in a loosely structured environment. A study conducted by Neuhauser (2002) hypothesized that introverted learners would do best online because they do not have to communicate with other students or teachers in the classroom. The type of modality Neuhauser thought would suite online learners is the visual modality because they can read off the computer screen. Convergors, as described by the Kolb Learning Style Inventory prefer abstract concepts and active experimentation (Collins, 2009; Miller, 2005). These learners prefer to deal with things as opposed to people. The Gregorc Style Delineator shows that Abstract Random learners will do best online because they like a personalized learning environment with room for interpretation on assignments (Miller, 2005).

Studies have also looked into common characteristics of traditional print students. Brown (2011) hypothesized that dependent learners are learners that are more traditional. These learners rely on the teacher and the students in the class to aid in their learning. Extraverted learners who like communicating with teachers and their peers also do better in traditional courses (Neuhauser, 2002). Egocentric students who are competitive and find course activities boring do better on paper



then doing the tests online because they like to compete with their fellow students to be the best (Clariana & Wallace, 2002; Collins, 2009). According to the Kolb Learning Style Inventory, Assimilators prefer abstract concepts and reflective observation (Collins, 2009; Miller, 2005). These learners find theory and facts very important. Concrete Sequential Learners as shown by the Gregorc Style Delineator will do best on paper because they prefer guided practice and support (Miller, 2005).

Many learning style instruments have been created to determine students' learning styles. When choosing a learning style instrument it is necessary to define the intended use of the data, match an instrument to intended use, and select the appropriate instrument, address the impact of difference social dynamics on learning preference (Diaz & Cartnal, 1999). Neuhauser (2002) used the modality preference inventory, which categorizes learners based on visual, auditory, or kinesthetic/tactile learners. Many studies used Kolb's Learning Style Inventory to categorize learners (Lu, Jia, Gong, & Clark, 2007; Zacharias, 2011). This inventory compares two different dimensions, doing versus reflecting and experiencing versus thinking (Collins, 2009). Four learning style groups emerge from this and those include convergers, assimilators, accommodators, and divergers. Studies have also used the Grasha-Riechamann Student Learning Style Scale, which creates six types of learners including, independent, dependent, avoidant, participant, collaborative, and competitive. Students fall on a range of these different traits characterized by the scale (Brown, 2011; Collins, 2009).

Another inventory used by researchers is the Gregorc Style Delineator (Collins, 2009; Miller, 2005). This inventory shows how students prefer information expressed. It compares perceptual and ordering abilities on

two dimensions. Either abstract or concrete for perceptual and sequential or random for ordering. These different preferences create four different types of learners. The first is concrete sequential learners who are practical, organized, and work well within time limits. Another type is abstract sequential learners who are probable, like research, and use logic. Another type is abstract random learners who like to listen to others and develop positive relationships with their peers. The final type is concrete random learners who develop creative ideas, think fast, and are good problem solvers.

With many different types of inventories to determine learning styles and preference, there have been many mixed results about which students perform best on paper-based versus computer-based assessments. The main problem with the results is the type of instrument being used to identify individual preferences (Brown, 2011). Zacharias (2011) found that there was no statistically significant difference in students learning achievement in online and face-to-face courses in terms of effects of students learning style according to the Kolb Learning Style Inventory. Miller (2005) and Lu, Jia, Gon, and Clark (2007) both found that Kolb's learning style inventory produced no statistically significant difference between learning style and learning outcome. Miller (2005) and Collins (2009) both found that the Gregorc Style Delineator produced a significant difference in scores. Miller (2005) found that concrete sequential learners learned significantly less than students identified as abstract random learners who learned 21% more or concrete random learners who learned 15.6% more on computer-based assessments.

Participants in the current study were college-aged students mainly enrolled in lower level psychology courses. They performed a reading comprehension task on paper or on a computer and completed the Gregorc Style



Delineator, which found significant results for both Miller (2005) and Collins (2009). This study focused on reading comprehension, which had not been previously studied in terms of learning style based on the Gregorc Style Delineator and scores on paper versus computer based assessments. Their score on the reading comprehension was compared with their learning style shown by the Gregorc Style Delineator. It was predicted that students who score highest in Concrete Sequential will perform the best in the paper-based test when compared to the computer-based test. In addition, students who score highest in Abstract Random learners will do the best on the computer-based test when compared to the paper-based test.

Method

Participants

For this experiment, 67 college undergraduates were used as participants. They ranged in age from 18 to 55, with the majority of participants being between 18 and 22.

They were all enrolled in lower level psychology courses at Minnesota State University Moorhead. Extra credit was offered for their participation in this study. They were a convenience sample of interested students who signed up for the study entitled, "Learning Style and Test Taking" outside of the psychology offices.

Materials

Before beginning the experiment, participants were asked to fill out an informed consent form. Participants first read a prose fiction short story as shown in Appendix A. And answered the 9 multiple choice questions also shown in Appendix A. Participants then completed a Gregorc Style Delineator see

Appendix B for an example. Finally, participants completed a background information sheet that details their age, gender, and if they have taken online classes before (see Appendix C for a copy). The short story was one page and is about a boy who after being in foster care, ends up helping younger kids at a local community center he hangs out at.

Procedure

Half of the participants, 34, were randomly assigned into the computer-based test group. They began by signing an informed consent. After this had been done they will start with reading the short story and then answering the questions. Both the short story and the questions were displayed on a computer screen. Upon completion of the test portion, they completed the Gregorc Style Delineator. This test will place them into one of two learning style groups. This will be completed on paper to keep it standard in both groups. Once their learning style had been determined, they filled out the background information sheet. After all steps were completed, they were debriefed and given a white experiment participation card.

The other half of the participants, 33, were randomly assigned to the paper-based test group completing everything the same, the exception was that the reading comprehension short story and comprehension questions were administered on paper, instead of a computer screen. The look of the story and questions was identical on the computer screen and paper to remove any effect from the look of how they are displayed. It took most participants 20 minutes to complete the entire experiment.

Results



The researcher calculated the number of errors made on the reading comprehension test. Table 1 displays means and standard deviations for the media the test was presented on and the determined learning style. As expected Concrete Sequential, participants made fewer errors on paper ($M= 2.69$, $SD= 0.87$) and more errors on computer ($M= 3.20$, $SD= 1.42$). Unexpectedly, Abstract Random participants made fewer errors on paper ($M= 2.76$, $SD= 1.79$) and more errors on computer ($M= 2.84$, $SD= 1.34$). A 2x2 factorial ANOVA was conducted to see whether the type of media the test was displayed on had an effect on number of errors made, also whether the learning style had an effect on the number of errors, or if there was an interaction between learning style and the type of media that the test was displayed on. There were no significant results from the determined learning style ($F(1, 63) = 0.17$, $p= .68$, $r^2 = 0.003$), from the media the test was presented on ($F(1, 63) = 0.74$, $p= .39$, $r^2 = 0.012$), or the interaction ($F(1, 63) = 0.40$, $p= .53$, $r^2 = 0.006$). Figure 1 shows the emerging pattern that the results are beginning to show.

Discussion

The hypothesis previously stated hoped to find that Abstract Random participants would perform better on computer and Concrete Sequential participants would perform better on paper. However, there were no significant results in the study there do seem to be the beginning of a pattern forming. The test mode effect (Clariana and Wallace, 2002) can help to explain some of the results. Both Concrete Sequential participants and Abstract Random participants performed better on paper, which the test mode effect said paper tests generally perform better. The number of errors made on computer by the Concrete Sequential was going in the right direction. They did end up making more mistakes on computer just not

significantly more. Because the results were not significant, it cannot be said with certainty that learning style has an effect on the performance of computer versus paper based reading comprehension.

Miller (2005) and Collins (2009) had previously found significant results for the Gregorc Style Delineator. However, both of these studies were using scores from a yearlong online or traditional classroom course instead of just a one-time measure like the current study. Many other modes of learning go into learning in an online class other than reading comprehension, which was the only focus of the current study. Future research can look objectively into the different modes of learning that take place in an online classroom versus a traditional classroom to attempt to figure where the difference in scores comes from.

A few limitations of the current study include not enough participants to make the groups large enough to get a sense of the general population. The four experimental groups ranged from 15 to 19 participants so increasing the number of participants in each group could lead to results that are more significant. Another limitation to the current study is the possibility for distraction; students walking by or talking while they were trying to complete the reading comprehension test may have distracted the participants. A final limitation is the testing material may have been too difficult. None of the participants received a perfect score creating a floor effect on the results.

Future research can aim to attempt to find the cause of the test mode effect if it is learning style, another participant variable, or something to do with the presentation of the media. Testing participants on both computer and later on paper can help to serve as participants being their own control and looking to see if that can provide significant results. When students are deciding whether or



not to take online classes for now it cannot be said for sure if learning style should be considered. However, every student is different and needs to understand how they learn best in deciding whether or not to take online versus traditional classroom courses.

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Table 1
Average Number of Errors Made For Learning Style and Presentation of Test

	Paper	Computer
Abstract Random	$M= 2.77$ $SD= 1.79$	$M= 2.84$ $SD= 1.34$
Concrete Sequential	$M= 2.69$ $SD= 0.87$	$M= 3.20$ $SD= 1.42$

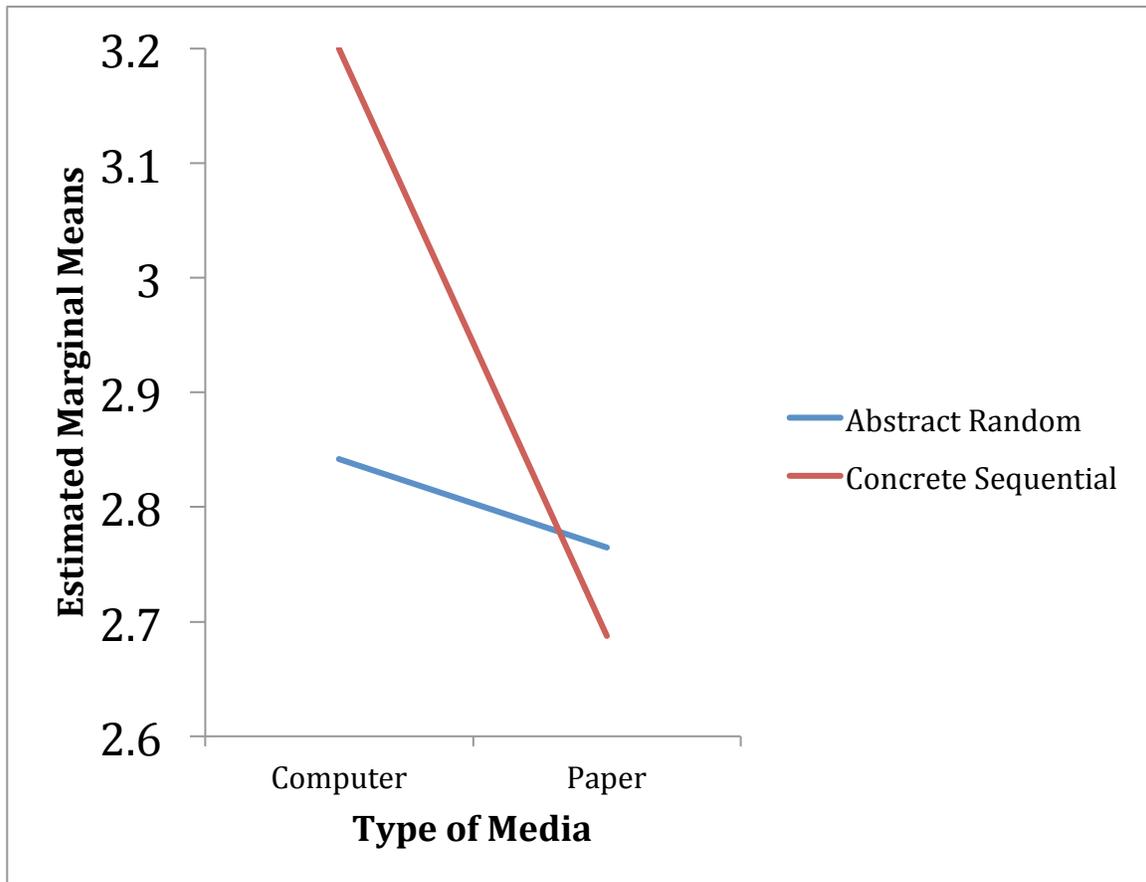


Figure 1. The graph above shows the interaction between presentation of test and learning style.

Appendix A

Reading Comprehension Short Story and Questions

PROSE FICTION: This passage is adapted from the novel *The Men of Brewster Place* by Gloria Naylor (©1998 by Gloria Naylor).

Clifford Jackson, or Abshu, as he preferred to be known in the streets, had committed himself several years ago to use his talents as a playwright to broaden the horizons for the young, gifted, and black—which was how he saw every child milling around that dark street. As head of the community center he went after every existing grant on the city and state level to bring them puppet shows with the message to avoid drugs and stay in school; and plays in the park such as actors rapping their way through Shakespeare's *A Midsummer Night's Dream*. If he broadened their horizons just a little bit, there might be enough room for some of them to slip through and see what the world had waiting. The kids who hung around the community center liked Abshu, because he never preached and it was clear that when they spoke he listened; so he could zero in on the kid who had a real problem.

Abshu wished that his own family could have stayed together. There were four of them who ended up in foster care: him, two younger sisters, and a baby brother. He understood why his mother did what she did, but he couldn't help wondering if there might have been a better way. The Masons lived in a small wooden bungalow right on the edge of Linden Hills. And Mother Mason insisted that they tell anybody who asked that they actually lived in Linden Hills, a more prestigious address than Summit Place. It was a home that was kept immaculate.

But what he remembered most about the Masons was that it seemed there was never quite enough to eat. She sent them to school with a lunch of exactly one and a half sandwiches—white bread spread with margarine and sprinkled with sugar—and half an apple. When Abshu dreamed of leaving he had his own apartment with a refrigerator overflowing with food that he gorged himself with day and night. The Masons weren't mean people; he knew he could have ended up with a lot worse.

Abshu lived with these people for nine years, won a scholarship to the local college, and moved out to support himself through school by working in a doughnut shop. By this time his mother was ready to take her children back home, but he decided that since he was already out on his own he would stay there. After he graduated with his degree in social work, he might even be able to give her a little money to help her along.

One thing he did thank the Masons for was keeping him out of gangs. There was a strict curfew in their home that was rigidly observed. And church was mandatory. “When you're out on your own,” Father Mason always said, “you can do whatever you want, but in my home you do as I say.” They were stingy with their food and with their affection. Existing that way all the time, on the edge of hunger, on the edge of kindness, gave Abshu an appreciation for a life fully lived. Do whatever job makes you happy, regardless of the cost; and fill your home with love. Well, his home became the community center right around the corner from Brewster Place and the job that made him most fulfilled was working with young kids.

The kids who hung out at the community center weren't all lost yet. They wanted to make use of the tutors for their homework; and they wanted a safe place to hang. His motto was: Lose no child to the streets. And on occasion when that happened, he went home to cry. But he never let his



emotions show at work. To the kids he was just a big, quiet kind of dude who didn't go looking for trouble, but he wouldn't run from it either. He was always challenged by a new set of boys who showed up at the center. There had to be rules some- place in their world, some kind of discipline. And if they understood that, then he worked with them, long and hard, to let them see that they could make a difference in their own lives.

Questions:

1. The point of view from which the passage is told can best be described as that of:
 - A. a man looking back on the best years of his life as director of a community center in a strife-ridden neighborhood.
 - B. a narrator describing his experiences as they happen, starting with childhood and continuing through his adult years as an advocate for troubled children.
 - C. an unidentified narrator describing a man who devoted his life to neighborhood children years after his own difficult childhood.
 - D. an admiring relative of a man whose generosity with children was widely respected in the neighborhood where he turned around a declining community center.
2. It can reasonably be inferred from the passage that which of the following is a cherished dream that Abshu expects to make a reality in his lifetime?
 - F. Establishing himself financially so as to be able to bring his original family back under one roof
 - G. Seeing the children at the community center shift their interest from sports to the dramatic arts
 - H. Building on the success of the community center by opening other centers like it throughout the state
 - J. Expanding for some, if not all, of the children the vision they have of themselves and their futures
3. It can reasonably be inferred from the passage that Abshu and the Masons would agree with which of the following statements about the best way to raise a child?
 - A. For a child to be happy, he or she must develop a firm basis in religion at an early age.
 - B. For a child to be fulfilled, he or she must be exposed to great works of art and literature that contain universal themes.

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- C. For a child to thrive and be a responsible member of society, he or she must develop a sense of discipline.
- D. For a child to achieve greatness, he or she must attach importance to the community and not to the self.
4. It can reasonably be inferred that which of the following characters from the passage lives according to Abshu's definition of a life fully lived?
- A. Mother Mason
- B. Father Mason
- C. Abshu as a child
- D. Abshu as an adult
5. Which of the following statements about the children entering the community center is supported by the passage?
- F. They had unrealistic expectations that Abshu toned down in the course of informal conversations.
- G. In Abshu's eyes, they were all gifted.
- H. In Abshu's eyes, the children who were likely to succeed were the ones who gave him the most trouble at the outset.
- J. They were prepared to believe in each other more than in themselves.
6. It can reasonably be inferred from the first paragraph that in obtaining outside funding for the community center, Abshu could be characterized as:
- A. thorough in seeking out potential sources for financial backing.
- B. reluctant to spoil the children with charity.
- C. excited about having the children write grant applications.
- D. determined to let the children decide how the money would be spent.
7. Which of the following statements about Abshu's attitude toward his mother's choices early in his life is supported by the passage?
- F. Abshu wishes he could get over the bitterness he feels toward her for allowing him and his siblings to be placed in foster care.
- G. Abshu is worried that his mother is troubled by her decision to place her children in foster care and wants to comfort and support her now that he is a grown man.

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- H.** Abshu wonders if she might have made a better decision about letting him and his siblings go into foster care, even though he understands why she did it.
- J.** Abshu wants to apologize for having been ungrateful as a child to his mother, who was only doing what she felt was best for her family.
- 8.** As it is used in line 65, the term *the edge* refers to a place where Abshu felt:
- A.** most alive.
 - B.** unfulfilled.
 - C.** defeated.
 - D.** most competitive.
- 9.** According to the passage, which of the following most closely identifies Abshu's definition of a life fully lived?
- F.** Happiness in your work and love in your house
 - G.** The pursuit of your goals and the realization of your dreams
 - H.** Togetherness with your family and the sharing of laughter
 - J.** Working in the community and striving for equality

Appendix B

Gregorc Style Delineator

1. Mark two words within each set that best describe you.

- | | |
|-------------------------|----------------------|
| 1. a. Imaginative | c. Cooperative |
| b. Investigative | d. Logical |
| c. Realistic | 8. a. Intellectual |
| d. Analytical | b. Sensitive |
| 2. a. Organized | c. Hardworking |
| b. Adaptable | d. Risk-taking |
| c. Critical | 9. a. Reader |
| d. Inquisitive | b. People person |
| 3. a. Debating | c. Problem Solver |
| b. Getting to the point | d. Planner |
| c. Creating | 10. a. Memorize |
| d. Relating | b. Associate |
| 4. a. Personal | c. Think-through |
| b. Practical | d. Originate |
| c. Academic | 11. a. Changer |
| d. Adventurous | b. Judger |
| 5. a. Precise | c. Spontaneous |
| b. Flexible | d. Wants direction |
| c. Systematic | 12. a. Communicating |
| d. Inventive | b. Discovering |
| 6. a. Sharing | c. Cautious |
| b. Orderly | d. Reasoning |
| c. Sensible | 13. a. Challenging |
| d. Independent | b. Practicing |
| 7. a. Competitive | c. Caring |
| b. Perfectionist | d. Examining |



- 14. a. Completing work
- b. Seeing possibilities
- c. Gaining ideas
- d. Interpreting

- 15. a. Doing
- b. Feeling
- c. Thinking
- d. Experimenting

*Scoring – For experimenter only***2. After completing the test above:**

In the columns below, circle the letters of the words you choose for each number. Add your totals for the columns. Multiply the total of each column by 4. The box with the highest number describes how you most often process information.

	I	II	III	IV
1.	C	D	A	B
2.	A	C	B	D
3.	B	A	D	C
4.	B	C	A	D
5.	A	C	B	D
6.	B	C	A	D
7.	B	D	C	A
8.	C	A	B	D
9.	D	A	B	C
10.	A	C	B	D
11.	D	B	C	A
12.	C	D	A	B
13.	B	D	C	A
14.	A	C	D	B
15.	A	C	B	D
Totals	_____	_____	_____	_____

I. _____ x 4 = _____ **Concrete Sequential**

II. _____ x 4 = _____ **Abstract Sequential**

III. _____ x 4 = _____ **Abstract Random**

IV. _____ x 4 = _____ **Concrete Random**

Appendix C

Background Information Sheet

Participant Number _____

Background Information

1) Age: _____

2) Year in college: _____

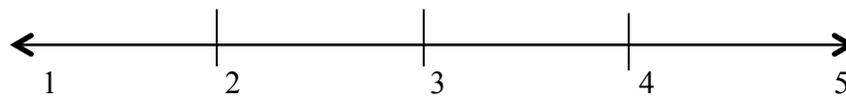
3) Major: _____

4) Circle your computer familiarity on the scale below:

1 = None: use computers with difficulty about once a week

3 = Moderate: use computers multiple times a week doing basic tasks (checking email, printing homework)

5 = High: use computers skillfully on a daily basis



5) Past experience with completely online classes:

Yes**No**

If yes, what classes have you taken?