CHAPTER 5-DISCUSSION AND CONCLUSIONS

Two instruction modules were developed and offered on-line through the Internet to post-secondary engineer and science students to determine how well they learn through the Internet. Why should educators, administrators, parents and other stakeholders support research in the use of the Internet in classrooms and schools? There are many reasons for using the Internet. Some of the reasons include a higher equity of access, an infinite resource, students as active participants, motivational influence of authentic learning activities, student inquiry and cooperative learning, and improved assessment of student progress. However, a major issue of concern to educators is how to effectively design and evaluate different learning formats on the Internet (Huang, 1997). The Internet has gained attention in education today because of its prevalence and ability to provide low cost education, in addition to making learning easier, more effective, and increasing enjoyment (Palmieri, 1997). The introduction of computers into the educational arena represents yet another facet of learning in an informal or free choice setting, such as museums and zoos. Koran, Longino, and Shafer (1983) have found that a considerable amount of sensory stimulation and learning appears to be influenced in these free-choice settings. In addition, Koran (1984) indicates that curiosity is a response to a novel stimulus, including manipulatable and diverse objects such as computers. Therefore, the more curious, the stronger the attracting and holding power, and the higher the attention, thus the more Internet visitors will learn.

Innovative approaches plus access to appropriate technologies will hopefully lead to the creation of new learning environments that are flexible and provide a custom education for each student, regardless of class size, time and distance constraints, previous preparation, and personal factors. However, passively hoping that normal learners will be able to activate appropriate learning strategies in an informal learning environment, such as the Internet, without guidance is insufficient to ensure successful learning and development. Therefore, with research in the area of learning theories (constructivism and objectivism) and self-regulation/self-efficacy, teachers can capitalize on the potential power of using the Internet as an informal learning setting for instruction. Greeno and Hall (1998) suggests the approach of situation cognition or situative perspective in these types of informal learning settings. A situative perspective emphasizes those practices in which students participate as they learn within the context of that particular learning environment. The Internet can provide this mechanism for participation. For example, if students' learning activities include formulating questions and proposing and explaining alternative solutions while they are using a computer, they can learn how to participate in those activities of inquiry. However, if they learn to give only the answers and explanations that are specified by teachers and textbooks, they are likely to learn the practices of memorizing.

Five forms were developed to gather data on how participants incorporated information presented in the instruction modules and what individual characteristics, such as gender, age and racial identities, may have assisted in their success. The study was designed to (a) identify optimal instructional formats for on-line learning; (b) identify differences in response to presentation formats with respect to gender, age or racial identity; (c) examine the effects of verbal aptitudes on learning in different formats; (d) identify relationships between computer attitudes and achievement; and (e) identify the potential power for self-regulated learning and self-efficacy on Internet WebPages. The findings for each null hypothesis tested in this study are discussed below.

Hypothesis 1: There is No Significant Difference between Constructivist and Objectivist Presentation Instructional Formats in an On-Line Learning Environment.

When science instruction is presented in linear and non-linear formats to science and engineering post-secondary students via the Internet, there are no significant differences in their post-assessment scores. The mean pre- and post-assessment scores for students who completed a constructivist format were 3.1 and 5.9 compared to the mean scores of 3.8 and 7.0 for the students who completed an objectivist format. A score of 10 was possible for these assessments. As a comparison, the mean pre-assessment score for the control group was 3.9 and the post-assessment score was 4.0. Using analysis of covariance (ANCOVA), it was determined that regardless of participant characteristics, post-secondary, technically oriented students were able to learn using

two different instructional module formats. The students were able to increase their post-assessment scores significantly over their pre-assessment scores as well as the control groups scores. Therefore there was improvement after completing the on-line instructional module. Limited prior research (Oliver & Herington, 1995; Chen, 1996; Chau, 1997; Block, 1997; Wilson, 1997) has been performed on the topic of how people learn on the Internet supporting these findings. One study has shown that when constructivist and objectivist frameworks were compared for computer aided instruction, the results showed that the objectivist group scored significantly higher on recall, forced-choice questions (Thede, 1995). Open-choice items were not included.

Pure constructivism is not a theory about teaching. It is a philosophy about knowledge and learning. Learning occurs daily and relentlessly inside and outside of classrooms (Brooks & Brooks, 1993). In addition, the constructivist view, the role of the instructor is not to dispense knowledge but to provide students with opportunities and incentives to build concepts with the information provided (von Glaserfeld, 1996). It appears that the Internet should promote this approach. Even more critical is the increase use of the Internet today in education. The 1990's have seen the Internet coming into its own as students began to use it as a learning tool instead of only as a research vehicle. The nonlinear organization of text and graphics on the World Wide Web (WWW) allows greater user control. A constructivist approach permits clear mental representation of concepts and the freedom for each learner to explore (O'Carroll, 1997). In this manner, the constructivist approach allowed the participant to wander through the instructional module accessing information in his or her own individual style. Whereas, the participant completing the objectivist module experienced a linear approach to instruction. Both the constructivist and the objectivist modules contained the exact same information.

The finding of increased post-assessment over pre-assessment scores provides support for on-line education via distance learning curriculum using electronic media resources such as the Internet. Jegede (1989) has found that the Internet provides teachers the opportunity to use several teaching methods in and out of their classrooms. The important point is that science can effectively be taught using specifically designed instructional modules placed on the Internet. Since there was no difference in post-assessment scores between the instructional formats, the manner in which lessons are presented did not prevent students from learning. The specific format or style of instruction will depend on the prior experience and the characteristics of the learner and the objectives of the course. Research shows that educational on-line use can increase student performance (Follansbee, 1997). Students are expected to be fluent in information literacy skills and science education on-line enables them to explore a new set of experiences (Ebenezer, 1999). These new experiences capitalized to a limited extent on the strengths of an informal setting. In addition to learning, curiosity, psychomotor development, interest, appreciation, motivation, and generalization all could be considered among the desired outcomes of a visit to an informal setting (Koran & Koran, 1986). Learning in informal settings is an ideal environment where activities create opportunities for students to practice scientific inquiry, and to do so in a self-directed fashion where learners take responsibility of their own self-regulated learning (Gunstone, 1991). Falk and Dierking (1992) have found that informal settings are attractive to learners because they are influenced by the physical aspects of objects outside of their normal experience and they encounter an array of atypical experiences. All of the aspects mentioned by Falk and Dierking (1992) are present in the informal setting of Cyberspace. However, different types of informal settings, such as that found on the Internet may have different effects on characteristics, such as cognitive, affective and psychomotor. Greeno (1993) contends that the central claim of situative theory is that cognitive activities should be understood primarily as interactions between physical settings and the learner. Therefore the opportunity for learners to be situated in a setting which is closely related to the subject being taught should promote more appropriate knowledge acquisition.

Hypothesis 2: There is No Significant Difference in Gender, Age or Racial Identity with Post-Assessment Scores After Completing Different On-Line Instructional Formats.

Three primary demographic variables, including gender, age and racial identity were investigated to determine if one or more of these variables resulted in a significant difference in post-assessment scores after completing either the constructivist or the objectionist instructional module. As described earlier, of the 145

participants between the ages of 18-30, 84 were male and 61 were female and the racial identity was heavily biased toward white participants. A simple analysis of covariance (ANCOVA) was the statistical procedure used to examine the research hypothesis. This procedure revealed that gender and age were not significantly different between post-assessment scores and the variable of racial identity provided inconclusive results. Although many studies indicate that learners display more heterogeneity with respect to gender, age, and prior experience (Falk, Koran & Dierking, 1986), this phenomenon did not occur for this study.

Age:

It was anticipated that older participants might not perform as well on an on-line study due to the lack of computer experience during their early learning years. Overall the novel setting and lack of experience with computers could increase their anxiety and thus decrease performance. However, since the study population was narrowed to post-secondary engineers and scientist between 18-30 years of age, a range restriction may have minimized this effect of age on the results of the study.

As stated earlier in accepting the hypothesis, the ANCOVA did not detect a significant difference between the age of the participant and their respective post-assessment scores. The mean participant age was 22 and the corresponding post-assessment mean value for those completing the constructivist approach was 6.20, and for those using the objectivist module, it was 6.79. The ANCOVA uses the mean scores and did not show a significant difference between age and post-assessment scores.

Table 5 -1. Age ANCOVA Source Table.
Dependent Variable: Post-Assessment

Parameter	Estimate	T for Ho: Parameter= 0	Pr >/T/	Std Err of Estimate
Age	**0.068092426**	0.30	0.7678	0.23007969
Age*Group 1	**-0.302231921**	-1.21	0.2281	0.24956700
Age*Group 2	**0.106736978**	0.43	0.6701	0.24998681
Age*Group 3	0.000000000	0	0	0

At age = 0

Table 5 -2. Age General Linear Models Procedure with Least Square Means.

Group	Post Least Square Mean (at mean age)	Std Err Least Square Mean	Pr >/T/ Ho:LSMean=0
1	**6.20355342**	0.28608885	0.7678
2	**6.79314980**	0.29219505	0.2281
3	**3.63363589**	0.67836080	0.6701

However, after examining the learning slope of this data, it was determined that the lack of difference only occurred at the mean age. The ANCOVA uses a general linear model procedure, which produce slope estimate data for each parameter. When reconstructing the linear models graphically, an age distinction was evident. At the mean age of 22, the least square means produced a post score of 6.2035 for group 1 (constructivist); a 6.7931 for group 2 (objectivist) and the control data was 3.6336. When these data are used to calculate linear prediction through years (table 5-3), it shows that higher post-assessment scores are produced as participant age increases after completing the objectivist instructional module (see figure 5-1). This supports an earlier statement made by Thede (1995) concerning objectivist formats in computer aided instruction, although both forced and open-choice items were included in this on-line study.

Table 5-3. Linear Calculation of Years vs. Format.

Age	Format	Equation	Product
18	1 - Constructivist	6.2035 - (-.23) * 4 =	7.1235
	2 – Objectivist	6.7931 - (.18) * 4 =	6.0731
	3 - Control	3.6336 - (.07) * 4 =	3.3536
22	1	6.2035 =	6.2035
	2	6.7931 =	6.7931
	3	3.6336 =	3.6336
26	1	6.2035 + (-.23) * 4 =	5.2835
	2	6.7931 + (.18) * 4 =	7.5131
	3	3.6336 + (.07) * 4 =	3.9136
30	1	6.2035 + (-.23) * 8 =	4.3635
	2	6.7931 + (.18) * 8 =	8.2331
	3	3.6336 + (.07) * 8 =	4.1936

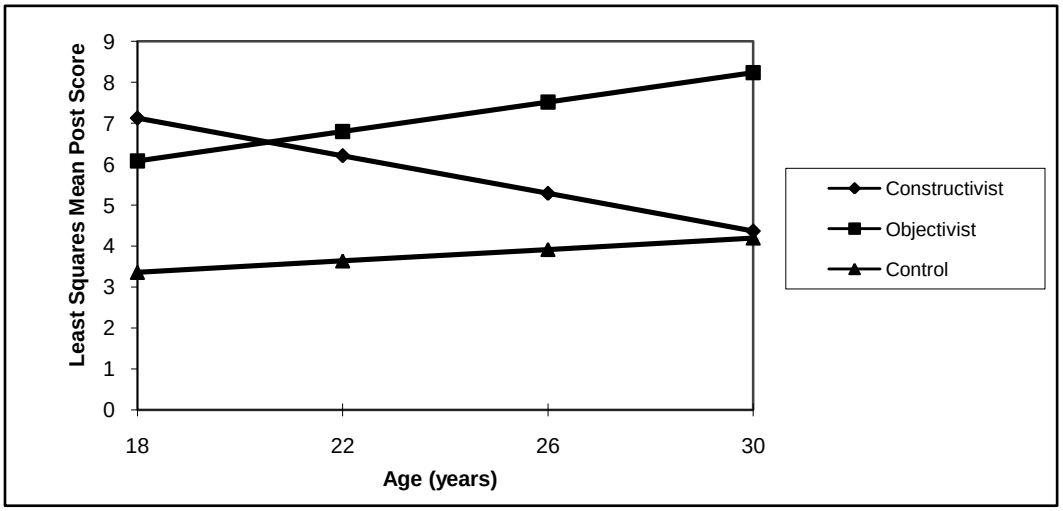

Figure 5-1. Linear Prediction of Format vs. Age

In this study, the restricted age range between 18-30 years produced a mean age of 22 and created a snapshot picture of data in time. When viewing the mean age of 22 on the graph (figure 5-1), it would initially appear that there is no significant difference between the two instructional modules as the ANCOVA indicates. However, examining the data in another manner indicates there could be a significant difference at $\alpha = .05$ between age groups on post-assessment scores, thus this portion of hypothesis two could be rejected when age is predicted beyond the means.

Although only a slight difference between post-assessment score exists for the two different instructional formats, this could be an indicator of a trend. If the study material was more general and younger students participated, the results may indicate that these younger learners may learn better through a constructivist approach. A conclusion that favors a constructivist instructional formats at lower ages would support Uddegrove's (1995) notion that teachers have recently shifted their educational approach from one of knowledge transfer (instructionalism or objectivisim) to one of knowledge building (constructivism) which depends on inquiry, student collaboration and peer teaching. It appears that even in a study where age range was relatively restricted a trend in the way students learn may be apparent.

Also, the younger participants of this study may have had more experience with the new technology of the Internet and the constructivist approach that it may offer. In contrast, the older participants may have operated on historical learning schemas, which were predominantly objectivist in orientation. This conclusion

could produce two differing opinions about the direction and development of instructional formats and the use of the Internet.

1. Is a constructivist instructional format best suited for younger learners only and post-secondary students perform better with objectivist approaches, such as lecture; or

2. Has there been a basic change in instructional philosophy, which coincides with the characteristics of the Internet's constructive environment that will benefit all learners.

Gender

The ANCOVA did not detect a significant difference between the gender of the participant and their respective post-assessment scores. Although various gender studies have resulted in males dominating the computer arena (Bernhard, 1992; Cassell, 1991; Collis & Williams, 1987; Comber, 1997; Wallace & Sinclair, 1995), this finding does not seem to be the case in this study where the science-related subject matter was restricted to participants with a highly technical background. There were 84 males and 61 females participating in the study which is a sufficient sampling that would allow a detection of significance if one were present. Many studies are not able to collect sufficient data points from different gender groups and therefore cannot provide conclusive evidence to their effects. The mean pre- and post-assessment scores for male participants were 3.6 and 6.4 compared to female participant scores of 3.3 and 6.0. A score of 10 was possible. Other factors examined between male and female participants also produced similar mean scores.

1. Attitudes toward computers produced a male to female result of 3.36 to 3.48;
2. Self-regulated learning and self-efficacy self-evaluation resulted in values of 4.64 to 4.82; and
3. Verbal comprehension was 23.4 to 23.1.

One possibility for the non-significance could be attributed to the study's subject range restriction due to age, subject matter and ability. Technically oriented post-secondary students were solicited to participate in a science-based instructional module on the Internet. The participants represented only a fraction of the general population, specifically future scientists and engineers. Since the instructional module was science-based and the primary objectives of the study were aimed at determining how well technical people learn through the Internet, a wider range of participants were not included. However, if a more generalized instructional module was presented and other fields of study were included, results could be significantly different between males and females. Therefore it appears that the lack of difference between gender in this study could be that individuals with a technical aptitude learn the same regardless of gender. Additional research would be helpful in this area to determine when a less technical topic is used, if results would detect a significant difference between males and females learning through on-line resources.

Racial Identity

As mentioned in the previous section, insufficient data were collected for participants with different types of racial identity. Out of the 145 participants, 111 were White, seven African American, three Native American, eleven Hispanic, and three Asian/Pacific Islander. Therefore, this portion of the hypothesis has produced inconclusive results with respect to performance of racial identity's and their post-assessment scores for on-line instructional modules.

Hypothesis 3: There is No Significant Difference in Verbal Aptitudes with Post-Assessment Scores After Completing Different On-Line Instructional Formats.

The ANCOVA did not detect a significant difference between the verbal comprehension of the participant and their respective post-assessment scores after completing either a constructivist or an objectivist instructional module. Verbal comprehension is the ability to understand the English language. A verbal comprehension test was used to determine general aptitude scores. Test reliability data calculated for the verbal assessment resulted in a Cronbachs alpha of .9002, a split half reliability of .8710, and with a Spearman correction, the split half reliability is .9311. Verbal comprehension was used as an indicator of general participant aptitude. Since interactions with instruction, structure and ability occur, aptitude tests have been

used an index of general ability (Koran, Koran, & Baker, 1980). Aptitude has been defined as any characteristic of the individual, which functions selectively with respect to learning; that is, which facilitates or interferes with learning from some designated instructional method (Cronbach & Snow, 1977). Aptitude-treatment interactions (ATI) reflect the notion of tailoring instruction to important student characteristics. They refer to differences in student outcomes as a function of the interaction of instructional conditions with student characteristics. Interest for science educators stem from the possibility that ATI may be used to adapt science instruction to fit different learners optimally (Koran & Koran, 1984). The verbal ability mean of 23.3 (SD 8.6) may be slightly elevated with reported values for post-secondary males and females. This is most likely due to the fact that the participants of this study were post-secondary individuals with advanced degrees and experience or that post-secondary students have been pre-selected on the basis of high ability, which in turn, restricted its range.

It appears that regardless of general aptitude, most post-secondary students can learn effectively through on-line resources. This aptitude indicator provides additional evidence that the usefulness of the Internet for educational purposes outside of the formalized classroom may be possible. Other aptitude indicators could be used and compared to the results of this study.

Hypothesis 4: There is No Significant Difference in Attitudes with Post-Assessment Scores After Completing Different On-Line Instructional Formats.

Statistical analysis did not detect a significant difference between the computer attitudes of the participant and their respective post-assessment scores after completing either a constructivist or an objectivist instructional module. There are many factors influencing Internet usage and some measure of participant's attitude or degree of technophobia should be included. An on-line computer attitudes survey was developed and piloted during a Survey Design course, spring, 1998 (Appendix B & C). This pilot resulted in reliability data for Cronbachs alpha of .8548 and split-half with a Spearman correction of .9045. This survey was used to identify relative positive or negative attitudes of the participants towards computers. Test reliability data calculated for the attitude survey for this dissertation resulted in a Cronbachs alpha of .7295, a split half of .7046 and with a Spearman correction, the split half reliability is .8267. The initial idea for this hypothesis from prior research was that people with positive attitudes about computers would perform better when using them while learning (Caprio, 1994; Comber, 1997; Durndell, 1995; Maurer, 1994). Age and attitude were variables that might cause the learner to become anxious, thus decreasing motivation, concentration and subsequent performance for on-line tasks. However, anxiety did not appear to be an issue in this study. People's attitudes toward computers typically range from apprehensive to confident and the differences in the educational arena are no exception. Differences in these attitudes can create an awkward learning environment. The result of student/teacher differences in familiarity of the new technology is a learning environment that resembles an Escher drawing of characters inhabiting a common physical space but living on different planes of existence that never interact (Bossert, 1997). The real value of computers is in helping us understand the powerful ideas that force us to change our ways of thinking and the most powerful weapon we have for exploring this new future is the one between our ears (Kay, 1997). However, there is some merit to caution because it is a mistake to emphasize connecting schools to the Internet without considering the kinds of thinking processes' students need in order to learn from the information they access (Goodman, 1997). The best approach is to take into account the curriculum orientation of teachers to help them identify barriers to the use of technology (Carroll, 1997).

Overall, it appears that in this study, attitude was not as important a factor to successful on-line learning, although a positive attitude may produce a more pleasant environment which may increase holding power, attention and possibly elevate performance for tasks of longer duration than this study provided.

Hypothesis 5: There is No Significant Difference in Self-Regulated Learners and Self-Efficacy with Post-Assessment Scores After Completing Different On-Line Instructional Formats.

A Motivated Strategies and Learning Questionnaire (MSLQ) developed by Pintrich (1995) was designed to assess post-secondary student's motivational orientations and their use of different learning strategies. In essence, this instrument identifies those who are self-regulated learners (learners controlling their own behavior, (Bandura, 1977)) and what they believe of their own capabilities (self-efficacy). Self-regulated learners are students whose academic learning abilities and self-discipline makes learning easier so motivation is maintained. Self-regulated learners a) tend to learn better under learner control; b) are able to monitor, evaluate, or manage their learning effectively; c) reduce instructional time required to complete the lesson; and d) manage their learning and time efficiently (Yang, 1993). Self-regulated learning strategies are actions and processes directed at acquiring information or skill that involve agency, purpose, and instrumentality perceptions by learners (Zimmerman, 1989).

One of the important questions for students, faculty and administration in post-secondary institutions today in the wake of massive influx of new computerized technology is the concept of distance learning (Sherritt & Basom, 1997). Colleges and universities are currently developing and offering various technical and non-technical courses remotely with variable success. Ideally, these programs would allow non-traditional students to participate in post-secondary courses while working full time jobs, or if they are simply unable to travel to the institution for on-site learning. Technology adds the ability for students to choose how, when, and where they participate in the learning experience and to bring together a vast wealth of previously unavailable learning resources (Forman, 1987). Also, distance learning allows the institution to generate additional revenue through tuition fees while minimizing the cost for the construction of additional facilities to house the students. However, in this seemingly win-win situation, the potential losers are the students, who are incapable of that kind of self-regulation through distance education on the Internet. In order to increase the success rate of distance learners, the institution could require a pre-assessment, which would determine the student's self-regulation in contexts such as the Internet. If the student achieved an acceptable score, they would be allowed to enroll in distance learning courses. If they were not acceptable self-regulated learners, the student could attend the course on-site where additional instruction, scheduling and mentoring are available.

Whereas self-efficacy influences the effort put forth, the duration and determination when confronted with obstacles and individual feelings. Students with high self-efficacy, work harder, persist longer when difficulties are present and achieve at higher levels. Successes raise and failures lower self-efficacy. Although low self-efficacy is detrimental, effective self-regulation does not require that it be exceptionally high (Zimmerman, 1991). A slightly lower sense of self-efficacy has been shown to lead to greater mental effort and better learning than does extreme confidence (Salomon, 1984). A more specific self-efficacy instrument for computer learning would be helpful to identify potential candidates for distance learning based on this parameter.

The MSLQ is based on a general cognitive view of motivation and learning strategies. Norms are not provided for this survey because student's responses should vary as a function of different topics addressed. In this case, the research topic is computers and the Internet. For this study, test reliability data calculated for the MSLQ resulted in a Cronbachs alpha of .9177, and a split half reliability of .9410 with a Spearman correction of .9696. Historical research (Chi et al., 1994; Chi & Bassok, 1989; Hagen & Weinstein, 1995; Pintrich & DeGroot, 1990; Schunk, 1988) demonstrates that if an individual is able to regulate their own learning and believes highly in their own capabilities, an elevated post-assessment score would be predicted for this study. However, the results do not indicate this to be true. There are a variety of reasons for this unanticipated outcome which include the following.

1. Typically, successful post-secondary students in technical fields are self-regulated learners with high self-efficacy. Since most of the participants have this characteristic, a difference in this parameter was not observed.
2. Post-secondary students in the field of science and engineering have adapted to become effective self-regulated learners with high self-efficacy due to the abundance of objectivist instruction.

3. The particular science related subject matter requires higher order skills, which correlate positively with self-regulated learning and self-efficacy, thus the subject matter creates a restriction, which could not detect a significant difference.

Summary

The information processing (IP) model of learning and memory (Figure 2-1, Atkinson & Shiffrin, 1968, 1971) provided the theoretical foundation for this study and a method to examine the input stimulus of an on-line web page. The IP model provides for subsequent attention and learning by processing information from short term, or working memory to long term memory for retention and future retrieval. This study used the IP model in the informal setting of Cyberspace and examined how the constructivist and objectivist instructional modules were affected by the characteristics of the participants, such as gender, age, racial identity, attitude, aptitude and self-regulation/self-efficacy. The various on-line forms provided information on how each participant viewed themselves and how they performed through on-line instruction by completing each module and then responding to the assessments.

Electronic instructional modules were developed and downloaded on-line (http://www.erc.ufl.edu/Study/Consent.html) to quantify how post-secondary, technically oriented participants learn science concepts through the Internet. Although a significant difference was detected between the instructional groups and the control and one part of the original five hypotheses, the outcome of non-significant results have important implications for learners. There are promising indicators that the World Wide Web is a viable means to increase student access, enjoyment and performance for education. Evidence on how the Internet can promote learning is not as forthcoming (Owston, 1997). The fact that all participants significantly increased their post-assessment over their pre-assessment scores indicates that post-secondary students can learn technical concepts through the Internet. This result provides some of the evidence Owston referred to and supports Forman's (1987) statement that the Internet can be highly valuable as a resource tool for education. This finding is an important contribution in support of using the informal setting of Cyberspace as a supplement to formal education in the classroom.

The only significant difference detected in this study was when age was compared to post-assessment scores. For the range of ages of this study, at age 18, the participant viewing the constructivist instructional module would score 7.1 in a post-assessment, although if projected to the 30 years upper limit of the study's age range, a lower score of 3.9 would be expected out of a possible 10. Therefore, the importance of teaching a particular format on-line to various age groups should be examined prior to implementation of instruction through the Internet.

There was no significant difference between gender and post-assessment scores after completing either instructional format probably due to an overall range restriction of the study. Gender does not appear to be a performance factor for technically oriented participants learning science-based information on-line through the Internet. This finding is important because there has been previous research (Cassell, 1991; Collis & Williams, 1987) indicating that gender affects were similar to mathematics and science topics, whereas males when compared to females achieved higher success. It could be that using the Internet potentially "de-genders" certain concepts and aligns the playing field for all learners. In this manner, traditional concepts, which were thought to have been affected by gender, may find that using the Internet could minimize these undesirable affects. In addition, teachers would not be able to differentiate between males and females when assessing student progress if codes are used instead of names when submitting assignments.

The significant difference between racial identity and post-assessment scores after viewing each instructional module could not be determined due to the lack of a racially diverse sampling group. Predominantly white post-secondary students volunteered as participants in this study. Additional research may be needed in this area, although it could be that this parameter may follow a similar pattern as gender and using the Internet could "de-racialize" learning certain concepts, thereby aligning the learning field. A similar coding as used with gender could be used by the instructor to eliminate unintentional bias when assessing the academic performance of minority students.

There was no significant difference in verbal comprehension, an indicator of general aptitude and post-assessment scores after completing each instructional module. The restricted range of subjects is a very plausible explanation for this parameter as well as others previously discussed. The participants represented a specialized group which possessed uncommon characteristics and therefore a significant difference was not observed for many of the results. Verbal comprehension scores were slightly elevated from high school norms, probably due to the restricted sampling of scientist and engineers which have higher intelligence and more extensive backgrounds. It appears that all levels of students with different aptitudes would be able to learn from instructional material through the Internet. This finding is an important outcome because it essentially indicates that all students, regardless of general aptitude and verbal ability could become successful on-line learners. The insignificance of this parameter on the difference of post-assessment scores may suggest an Internet equalizing effect for learners. However, to make a more general statement, participants with a wider range of characteristics would be required. Individuals could approach the on-line lesson with a wide variety of backgrounds, skill-sets, interest, abilities and objectives. Individual differences could be accounted for and each learner increases their opportunity for success.

There was no significant difference in computer attitudes and post-assessment scores after completing each instructional module. Again, the restricted target sampling of science and engineering majors may have a more uniform acceptance of computers and electronic media, thus, the format of this study did not intimidate them. Attitudes may affect older or technophobic participants who have not used computers during their education. However, a positive attitude toward computers could be fostered when direct, functional applications are presented as examples to the learners. Many historical technophobes are now technophiles due to the way they have correlated the use of computers to their interest, both professional and personal. Computers are not a one size fits all, but they have an inherent flexibility that can be modified by each user to adapt to a wide variety of topics. It seems that the major attitude hurdle for the technophobe to overcome may not be one of technological derivatives, but one of change and newness.

There was no significant difference in self-regulated learners with high self-efficacy and post-assessment scores after completing each instructional module. It is believed that science and engineer majors may incorporate these techniques in their learning process for a variety of reasons. Many of the individuals in this study may be classified as technically oriented learners. In as such, these learners are more analytical and logical in their thinking. Therefore, regardless of the topic, format, or objective, these students will tend to use self-regulating mechanisms to set goals, monitor, self-assess and modify their approach. Zimmerman (1989) describes these self-regulated learning strategies as actions and processes directed at acquiring information or skills that involve agency, purpose, and instrumentality perceptions by learners. This strategy seems to be a critical factor for students to become successful on-line learners.

Suggestions for Further Research

Ideas for further research would include:

1. In order to generalize to a larger population, future work would need to broaden the sampling group to include participants with backgrounds other than science and engineering. In addition, more general instructional module, such as math or a lower level science could allow a wider range of individuals to participate. Winne (1998) states the obvious about how little is known about instructional design issues that affect students' learning with technology. Almost all technological applications have been designed on the basis of theories developed for nontechnological settings. Keeping this in mind, broadening the type of participants and the design of the website may better enable a comparison between the results from this study and the potential to generalize to a wider audience of on-line learners. The power of this type of further research is the ability to make a global statement about the effectiveness of on-line learning. One of the 16 Characteristics of Schools and School Systems for the 21st Century (American Association of School Administrators, 1999), is that students and schools are connected around-the-clock with each other and the world through information-rich, interactive technology. Teachers, parents, students and administrators from all

areas would then be able to evaluate the feasibility of using electronic media, such as the Internet, inside and outside of their classroom.

2. Morris (1989) has found direct effects of age and education on computer attitudes. Results from a study by Polyakov and Korobeinikov (1996) imply that the ability to train and retrain participants on a 10 minute computerized test decreases with age. In addition, Westerman (1995) found that older participants perform more slowly at computerized information retrieval. Therefore, further research in the area of minimizing the age range restriction of this study would be worthwhile. By testing primary, secondary and older learners, it may be possible to detect actual differences in students for on-line learning activities. For instance, Chang (1994) found that junior high school chemistry students produced much higher explanation scores when presented instructional material in a contructivist approach. A similar on-line study using constructivist and objectivist approaches could be administered to these learners modifying the content for each age group.

3. Robinson (1998) concludes that in order to have access to information, individuals will need computer skills that are not only technical, but also social and cognitive. Schools have not provided equitable access for all students. Minorities and the poor still lag behind suburban schools. These conditions undermine learning the language of computing. Bhatti-Sinclair (1997) agrees and indicates that rather than acting as a liberating force, information technology can reinforce inequalities in society. There is evidence that groups which are discriminated against in society in general are further disadvantaged. Finally, Sutton (1991) has concluded that the use of computers has maintained and exaggerated inequities, with poor and minority students having less access to computers at home as well as at school. As technology advances, the cost of computer systems will decrease which may make them more common and therefore minimize the effect of availability. Future research should take into account whether the participants have easy access to computers. In this study, there was guaranteed access through the University of Florida computer laboratory system.

4. With respect to participant attitudes towards computers, Levine (1998) has indicated that beliefs lead to attitudes, and that attitudes are an important precursor to behavior. He further suggests that computer use has a positive effect on perceived computer self-confidence, as well as on computer-related attitudes. The attitudes of students toward computers are significant determinants of behavior that may influence computer utilization. Al-Khaldi and Al-Jabri (1998) has found that overall attitude affects computer utilization. In addition to attitude, other variables appeared to have a strong influence on computer utilization, namely the degree of computer experience, the degree of access to computers, and the number of computer- related courses taken. Anderson (1997) also agreed that course participation and previous experiences involving computer activities led to more positive attitudes toward computers. Courses with higher levels of direct involvement with computer applications led to the most positive attitude changes. Results from a Rocheleau (1997) show that computer ownership and student gender were the most important variables influencing computer usage. Student perception of their parents desire to use computers was also important. Findings demonstrate the influence parents can exert in increasing the probability that their children will be heavy computer users. Further research should take these factors into consideration prior to experimental design development and implementation.

5. The correlation between distance learning and a self-regulated learner has been mentioned earlier in this study. Further evaluation of this critical component in web-based environments would be beneficial. Relatively little is currently known about the acquisition of self-regulation and what can be done to facilitate its development. Winne and Stockley (1998) indicate that educational technologies help students develop knowledge, skills, motivation and academically effective forms of self-regulated learning. Furthermore, the power of a computer can work with a student providing continuous monitoring as has been suggested in a model for self-regulated learning (figure 2-2) (Zimmerman, Bonner & Kovach, 1996). A limiting factor to determining an individuals own self-regulated learning ability is the identification of an effective tool. Although Pintrich (1995) has provided the questionnaire used in this study, additional research in the area of a more objective self-regulated learning measurement mechanism would be beneficial.