Critical Thinking and Online Supplemental Instruction: A Case Study

Cassandra S. Shaw
Karen E. Holmes
Capella University

Abstract

A wealth of research is available regarding supplemental instruction; however, a dearth exists regarding online supplemental instruction and critical thinking. This case study explored what was assumed to be known of critical thinking and investigated the extent to which critical thought was promoted within a university's online supplemental instruction program. Survey and persistence data indicated the university's online SI program was successfully facilitating critical thinking. However, after conducting online session observations, based upon the Paulian critical thinking theory and the adoption of Bloom's taxonomy as a critical thinking model, the case investigation revealed the initial assumption was flawed.

Since its inception over four decades ago, Supplemental Instruction (SI) has consistently established a positive impact on student performance (University of Missouri, 2007). Ubiquitous studies, ranging from K-12 to higher education settings, have consistently replicated outcomes demonstrating that participation in SI is positively associated with higher academic performance as compared to those who do not participate in SI (Arendale, 2001; McGuire, 2006; Zaritsky & Toce, 2006; Zerger et al., 2006). Yet, there exists another contributor to higher course grades: critical thinking.

Facione (2011), a leading expert in critical thinking, posits a significant correlation exists between critical thinking skills and college grade point average (GPA). It logically follows that if one's

Cassandra S. Shaw | Capella University | cassandra.shaw@capella.edu

thinking improves then one's performance might improve as well. Facione (1990) proposes an educational responsibility toward fostering a "critical spirit" that includes building and strengthening core skills in interpretation, analysis, evaluation, inference, explanation, and self-regulation. Interestingly, these core skills are an ideal complement to Bloom's taxonomy—a critical thinking model employed by a leading online university that offers bachelor's, master's, and doctoral degrees to domestic and international students.

Capella University's SI program is one of the few, if only, *100 percent online* SI programs in higher education. Akin to university curricula objectives, SI session planners and online activities are designed to promote critical thinking through the application of Bloom's taxonomy. SI Leaders then facilitate the activities during synchronous sessions with the intention of cultivating a critical spirit. A question that came to the forefront of this case investigation was "How well does SI facilitate critical thinking skills?" A preliminary data examination of SI evaluation surveys and course grades revealed that students were gaining critical thinking skills through participation in SI. The data suggested that these critical thinking skills not only helped students with the current course, but also provided transferable critical thinking skills that could be applied to other courses.

Literature

Defining the construct of critical thinking was a significant first step toward establishing a foundation from which to conduct the case study. Halpern (2003) stated critical thinking generates new knowledge and that knowledge and thought are intrinsically linked to human cognition. Petress (2004) cited critical thinking as a "mode of thinking" and an "intellectually disciplined process." Facione (2011) stated critical thinking is a process in which the resulting outcome includes "thoughtful judgment" and "reflective decision making." These interpretations led to the inference that critical thinking facilitates the ability to address issues and solve problems through a disciplined process by which the end result can be justified by reason and evidence. As the construct of critical thought became more apparent through the literature, a question emerged as to what was assumed to be known of critical thinking. This propelled the case study into a

deeper realm in which skepticism usurped assumption.

Underpinning the interpretations by Halpern, Petress, and Facione, is the *what, why,* and *how* components of critical thought. The *what* component of critical thinking exemplifies characteristics of an intellectual mode of thinking, such as applying a logical, reasoned, rational, academic, or scholarly approach to thinking whereby justifications are accomplished through reason and evidence. Opinions and conjecture are prohibited as means for justification.

The *why* component examines the importance of critical thought: in other words, why should one think critically? Critical thought is of benefit or value to individuals, society, and culture because it is the global facilitator of enhanced thinking abilities and expanded breadth of knowledge (Facione, 2011). When justification is achieved through reason and evidence, human thought can generate new knowledge, ideas, and solutions, as well as practice fair-mindedness in thinking (Paul, 2011). Given the propensity of the average person to supply opinion as a means to substantiate an argument, it is not difficult to deduce that human nature is challenged to think critically.

So how can a person who is not inclined to think critically facilitate critical thinking? The *how* component of critical thinking refers to an intellectually disciplined process used to promote thoughtful judgment, reflective decision-making, and evidence-based reasoning (Facione, 2011; Huitt, 1998; Petress, 2004). The process alludes to methods used to increase awareness of critical thought so as to acquire basic critical thinking skills and intervene in faulty thinking. Subsequently, this case study needed to locate a fitting framework for facilitating the process of tackling the how component of critical thinking. The resulting outcome was the adoption of the Paulian critical thinking theory.

Paulian Critical Thinking Theory

The Paulian critical thinking theory purports the application of a specific critical thinking model. At the heart of defining Paulian critical thinking, lay three key facets (Elder, 2010, p. 2): Although it is human nature to think, it is not human nature to think well or critically. "Therefore, we need to be able to intervene in thinking, to

analyze, assess, and where necessary, improve it." Critical thinking is purposeful, has a goal, and utilizes reasoning (Halpern, 1998). According to the Paulian theory, there are multiple processes that should ensue, such as developing fair-mindedness through the eight elements of reasoning and harnessing critical thinking abilities. When incorporated into one's reasoning, these processes can strengthen critical thought and the incumbent nature to think well and to think without prejudice or illusion.

The eight elements of reasoning (Figure 1), or structures of thought, become the idea that all reasoning contains parts, and that these parts enable one to analyze thinking in order to best understand it (Paul, 2008). Each element has influence and is influenced by another. Where one element exists, the other seven exist, like a chain with eight links. All *products* of reasoning can be analyzed according to these eight elements (Figure 1) since all human reasoning contains the eight parts (Paul, 2008). These eight elements also impact our ability to develop fair-mindedness.

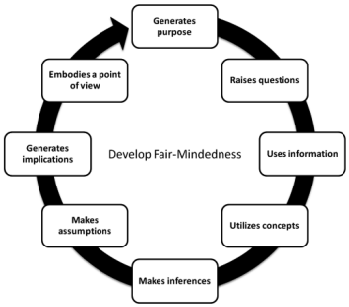

Figure 1. Flow chart depicting the process of developing fair-mindedness through the eight elements of reasoning.

According to Paul (2011), critical thinking ability can be described as a process or object of thought and an intellectual standard. Critical thinking ability involves the act of gathering relevant information. Connecting this ability to Paul's process of developing fair-mindedness, information gathering is used to generate a purpose, clarify issues, distinguish relevant from irrelevant information, raise questions, question deeply, practice Socratic discussion, and read critically (Paul, 2008). When making logical inferences, one uses information to compare and evaluate perspectives or theories and to compare

analogous situations to transfer insights to new contexts. Logical inference further helps to utilize concepts to generate or assess solutions, which leads to a refined generalization that avoids oversimplifications and leads to plausible interpretations (Paul, 2008).

Next, generating justifiable assumptions is tied to the process of making assumptions that arise when reasons are given and evidence and facts are evaluated. To pursue critical thought logically, one must generate implications by noting significant similarities and differences. Incorporating critical thinking with developing fair-mindedness can be accomplished by checking information for accuracy, through criterion development for that evaluation by clarifying values and standards. This further includes evaluating the credibility of sources where information was mined.

The essence of the Paulian theory purports that to think critically requires people to develop fair-mindedness at the same time they learn basic critical thinking skills, and thus begin to practice fair-mindedness in thinking. According to Halpern (1998), critical thinking utilizes cognitive abilities to increase a desirable outcome. Higher order cognitive skills are synonymous with critical thinking skills with a goal of providing useful feedback to improve thinking (Halpern, 1998). The Paulian theory of critical thinking purports the application of a specific critical thinking model. At Capella, Bloom's taxonomy is that model integrated into courses and student learning.

Bloom's Taxonomy

From academic, learning, and training perspectives, Bloom's taxonomy is familiar to many as a means to construct educational objectives. By crafting distinct objective statements that describe what a student is expected to learn, the use of Bloom's taxonomy for the classification of educational objectives defines and categorizes predetermined instructional learning outcomes (Krathwohl, 2002). The objective statement includes the application of a unique action verb that is aligned with a cognitive delineation of the taxonomy, whereby six delineations are representative of thinking from a simple to complex cognitive operation (Halawi, McCarthy, & Pires, 2009; Huitt, 2011; Krathwohl, 2002).

Conversely, Bloom's taxonomy also serves as a critical think-

ing model—in fact, its greater strength rests in its ability to facilitate critical thought rather than define educational objectives. The overarching taxonomy comprises three central domains: cognitive, affective, and psychomotor skills (Clark, 2010; Halawi, McCarthy, & Pires, 2009). However, the cognitive domain was the focus of this case study whereby the taxonomy represented "a systematic classification of cognitive operators" successively ordered from simple to complex, concrete to abstract (Krathwohl, 2002). The cognitive domain is comprised of six levels that sequentially reflect how thinking builds—beginning at a foundational level of thinking (knowledge) and working upwards to a more advanced, complex level of thinking (evaluation). Although the original model has since been revised, the newer version has not been universally adopted, and this study used the original model, which is also employed by the university.

Based on the original model, the six levels include—from simple to complex—knowledge, comprehension, application, analysis, synthesis, and evaluation. Each of these six levels implies a *magnitude of thought* and is further delineated into two realms of thinking: lower-order thinking (simple) and higher-order thinking (complex). As illustrated in Figure 2, knowledge, comprehension, and application comprise lower-order thinking and analysis, synthesis, and evaluation comprise higher-order thinking. Levels of the taxonomy are intended to be successive and imply that a level must be mastered before moving to the next level (Huitt, 2011). In addition, for purposes of this case study, the taxonomy was further delineated by academic levels whereby cognitive operations were aligned with academic settings. Overall, Bloom's taxonomy can be delineated by six cognitive levels, two realms of thinking, and three academic application levels (Figure 2).

As mentioned, the typical thrust of Bloom's taxonomy rests in its useful framework for creating and categorizing educational objectives, which involves the application of action verbs that are aligned with the taxonomy's cognitive delineations. However, to use the taxonomy as a means to explicitly promote critical thinking one needs to look past objective statements and contemplate the nature of the cognitive operations at each level. Beyond the action verbs, each level provides a description of how thinking builds and ascends a cognitive

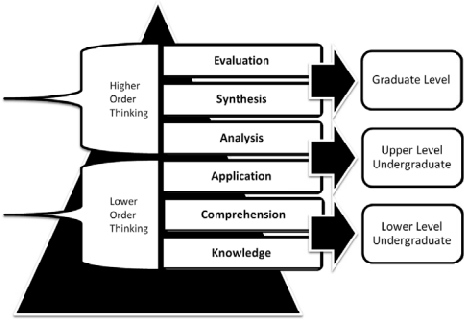

Figure 2. Graphical illustration depicting the delineation of Bloom's taxonomy according to cognitive levels, thinking realms, and academic levels.

echelon of operations (Table 1). Opportunely, the taxonomy's framework provides an excellent canvas to apply a questioning strategy, as the cognitive levels and associated action verbs provide the scaffolding for designing powerful questions.

Table 1

Description of the Cognitive Echelon of Operations

Level	Description
Evaluation	Presenting and defending opinions by making judgments about information, validity of ideas or quality of work based on a set of criteria.
Synthesis	Compiling information together in a different way by combining elements in a new pattern or proposing alternative solutions.
Analysis	Examining and breaking information into parts by identifying motives or causes, making inferences and finding evidence to support generalizations.
Application	Solving problems by applying acquired knowledge, facts, techniques, and rules in a different way.
Comprehension	Demonstrating understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating main ideas.
Knowledge	Exhibiting previously learned material by recalling facts, terms, basic concepts and answers.

For SI Leaders in an online synchronous environment, interaction with the students is vital and the means by which to interact can vary significantly from the traditional classroom environment. Ques-

tioning techniques provide a powerful tool toward challenging critical thought. However, an essential aspect concerns the matter of how to construct the questions so that there is significant alignment with the appropriate cognitive levels of the taxonomy. While the action verbs provide the scaffolding, construction of the question takes serious thought. For the case investigation, Paulian theory and Bloom's taxonomy afforded a foundational method to evaluate the extent to which SI Leaders were facilitating critical thought and a method to construct powerful questions for use during SI sessions.

Methods

A case study strategy was used to initiate the process of determining the strengths of Capella's SI program and to make recommendations for improvements. The original focus of the investigation was to identify the program's strengths of incorporating critical thinking skills in SI sessions; what was found, though, was that improvements were needed—How can an online SI program incorporate critical thinking skills? The answer was revealed through a two-part case study that began with an analysis of collected data that was comprised of ABC grade distributions and persistence rates of students that attended SI and student self-assessments of critical thinking skills learned as a result of participating in SI. Second, SI Leader observations were conducted using the critical thinking SI observation form developed from the creation of the evaluation model (Appendix A). Using data results, an erroneous theory was established that critical thinking strategies were being employed. From the data collection four drivers of perception materialized, which spurred two assumptions: 1) some programs/courses may present more or less opportunity for higher order thinking and 2) some SI Leaders may have more or less understanding of how to apply a critical thinking model.

The 1st perception driver consisted of data from the first critical thinking survey question in which students were asked to rate on a scale from 1-5, with 5 being the highest, their agreement that SI helped critical thinking skills for the current course. Figure 3 shows that between Q4 2011 and Q1 2012, 70%-75% of students strongly agreed or agreed that SI helped their critical thinking skills for their

current course. Through self-reports of positive changes and appropriate instruction, students become better critical thinkers (Halpern, 1998).

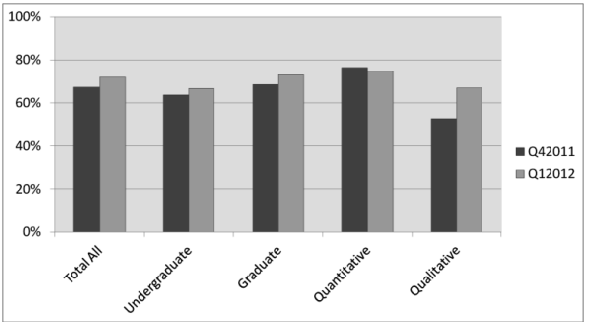

Figure 3. Excel output for bar chart agreement (percent of students) of end of quarter survey question (SI helped my critical thinking skills for this course).

The 2nd perception driver was data from the second critical thinking survey question where students were asked to rate on a scale from 1-5, with 5 being the highest, their agreement that critical thinking skills were learned in SI that can be carried forward to future courses. Figure 4 demonstrates that 60%-70% of students from Q4 2011 to Q1 2012 strongly agreed or agreed that they learned critical thinking skills that could be carried forward to future courses. This supports Yeh's research of integrating e-learning into a direct-instruction model that enhances critical thinking (2009); this integration can improve critical thinking not only for the student but for the SI Leader as well.

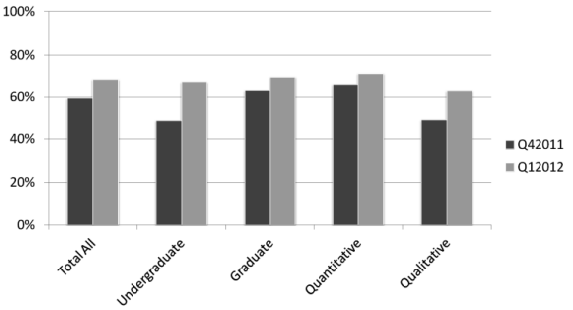

Figure 4. Excel output for bar chart agreement (percent of students) of end of quarter survey question (I learned critical thinking skills in SI that I can carry forward to other courses).

Persistence data drove the 3rd perception driver: did the SI student stay in the current course past the census date? In Figure 5, persistence rates for 2011 were quite high at 97%. The 4th perception driver involved the ABC distributions of SI students, and it revealed an overall average of 86% (Figure 6) of students that participated in SI for 2011 earned an A, B, or C. This led to the assumption that a correlation existed between grades and critical thinking, based on research from Facione (2011). Persistence and ABC distribution data helped to drive the perceptions that critical thinking was being employed in SI sessions and was being facilitated by the SI Leader based on work by Malm, Bryngfors, & Mörner (2012).

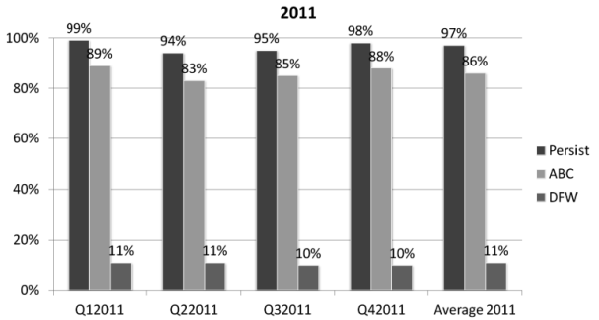

Figure 5. Excel output for bar chart persist rates and ABC versus DFW grades of students that attended SI for the year 2011.

To evaluate SI instructional practices, and the extent to which SI Leaders were actually facilitating critical thinking during SI sessions, it was necessary to develop an evaluation strategy that assimilated the constructs of Paulian critical thinking, Bloom's taxonomy, and online SI. By adopting principles from the Paulian theory and using the framework of Bloom's taxonomy, a method was created from which to devise a new model for evaluating SI instructional practices (Appendix A). The first step toward creating the new evaluation model involved targeting specific components of the Paulian theory that would serve as the foundation from which to construct the model. Accordingly, Paulian critical thinking theory components included: 1) explicit instruction, 2) critical thinking model, and 3) instructional practices. These three components provided the underpinning for assimilation of Bloom's taxonomy and online SI into the model.

The final step in creating the evaluation model involved assimilating all components from which the following implications evolved: development of fair-mindedness; use of Bloom's taxonomy to achieve higher-order thinking, as well as application of the taxonomy to academic program levels; implementation of a powerful questioning strategy to promote critical thought; and, application of tools and techniques to enhance online learning and collaboration. The result of the assimilation was a highly inter-related model (Figure 6). The upper row of the evaluation model reflects the targeted components of the Paulian theory that served as the foundation from which to construct the model. Recall that these components dictated the necessity to choose a critical thinking model and to implement specific instructional strategies, which is represented in the center row. The third row illustrates the complete assimilation of the Paulian theory, Bloom's taxonomy, and SI whereby the eight elements of reasoning are necessary to develop fair-mindedness; the upper echelon of Bloom's taxonomy is needed to promote higher-order thinking; and, the use of a powerful questioning strategy is used to promote critical thought in conjunction with enhancing learning and collaboration.

The evaluation model led to the construction of a critical thinking SI observation form (Appendix A). This observation form subsequently served as the method by which to effectively observe a range of SI sessions, and to evaluate the extent to which the SI program was achieving the goal of promoting critical thought in SI sessions.

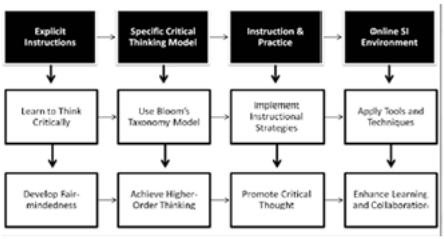

Figure 6. Graphical illustration of the new evaluation model involving the assimilation of the Paulian theory, Bloom's taxonomy, and online SI.

Results

In order to fully understand the baseline of critical thinking in SI sessions—what was being accomplished if critical thinking was

not evident—three SI Leaders were each observed during their own SI session: Business Undergraduate course, Advanced Statistics Graduate course, and Research Methods Graduate course. This offered a cross-sectional look at undergraduate and graduate as well as qualitative and quantitative course content. The case study of undergraduate and graduate level SI sessions occurred by using observations, student survey data, and hard data (persistence and grade distribution) with a purposeful random sampling. The following associated SI sessions were used for this study: in the undergraduate school—finance and accounting (BUS3060); in the graduate school—advanced statistics (PSY7625) and research methods (PSY7650).

During the Research Methods graduate SI session, opportunities for the SI Leader to develop critical thinking were observed, which meant a minor change by the SI Leader—reconstructing questions. The SI Leader was not taking the students past comprehension (level 2); they were not reaching a higher order of thinking needed for critical thinking (Halpern, 1998) in a graduate level course. Table 2 represents questions of opportunity for the SI Leader, which demonstrates how critical thinking can be integrated in a simple manner—through appropriate construction of questions.

Table 2

Opportunity Questions from an Observation for the SI Leader of a Graduate Level Course So Students Can Reach Higher Order Critical Thinking

Level	Level Name	Question
Level 2	Comprehension	What can you say about the topic?
Level 3	Application	What questions would you ask in an interview with a generation Y member to support the research problem?
Level 4	Analysis	What would the assumptions be for this research problem?
Level 5	Synthesis	What would be your expected results?
Level 6	Evaluation	How would you justify your intended methodology?

The second SI session observed was for undergraduate Business, which incorporated finance and accounting. It was expected that critical thinking would reach analysis (level 4) based on survey

data and that this was a Bachelor's level course. It was found that the SI Leader presented an income statement that purposely contained errors and that students were asked to identify the errors. Because students were correctly answering the questions, the SI Leader assumed she was incorporating critical thinking when in fact it occurred at level 1 of Bloom's Taxonomy—list the errors. While identifying the mistakes can involve a degree of application (level 3), higher order critical thinking stalled because the students were asked to list the errors and then move on. Table 3 represents the opportunities noted to elevate critical thinking.

Table 3

Opportunity Questions from an Observation for the SI Leader of an Undergraduate Level Course So Students Can Reach Higher Order Critical Thinking

Level	Level Name	Questions
Level 2	Comprehension	Why do you think that we need to double underline "Net Income"?
Level 3	Application	What would result if incorrect accounting was not acknowledged?
Level 4	Analysis	Why do you think it is important to ensure that each transaction is properly documented under the correct account?

The third observation was of a graduate level SI session—Advanced Inferential Statistics. At this level, a 700-level course, it was expected that critical thinking would reach the evaluation level of Bloom's Taxonomy (level 6). The realization was that instructional strategies were reduced to a demonstration of how to solve the problem whereby the SI Leader offered an explanation of how to perform every step. In this manner of "show and tell," learning was reduced to lower-order thinking—the memorization of calculation processes and answers, which was representative of knowledge (level 1). In reality, critical thinking strategies ranged within the lower order and up to analysis (level 4) and sometimes a hint of synthesis (level 5). For a graduate level SI session of this magnitude it should be reverse—a hint of lower order. Table 4 shows the opportunities found for this SI Leader, which again represent a simple change in construction of

questions being asked by the SI Leader to the students.

Table 4

Opportunity Questions from an Observation for the SI Leader of a Graduate Level Course So Students Can Reach Higher Order Critical Thinking

Level	Level Name	Questions
Level 4	Analysis	What evidence can you find to support using ANOVA?
Level 5	Synthesis	How would you design this using a stratified sampling?
Level 6	Evaluation	How will you defend your conclusion / point of view?

Discussion

It is undeniable that successful planning of any type of pedagogy, such as SI, can serve as the scaffolding to enhance critical thinking through the incorporation of ideas and strategies that represent the ways students organize knowledge and learn (Halpern, 1998). However, to transfer critical thinking skills through learning, SI Leaders must have sound critical thinking skills themselves and professional knowledge (Yeh, 2009) SI Leaders demonstrated professional knowledge through content knowledge of the particular subject matter. Conversely, the SI Leader's pedagogical knowledge of selecting appropriate questioning techniques using Bloom's Taxonomy was not effective.

Integrating Paulian critical thinking with Bloom's Taxonomy, Appendix B demonstrates the flow of the Paulian theory to cognitive ability to Bloom's Taxonomy. Through observations it was found that none of these factors were being incorporated in the SI sessions even though the idea that it was occurring was present; this really challenged perceptions and assumptions. SI Leaders were not being explicit with directly stating to students that they would be learning to think critically; it was an erroneous assumption. A specific critical thinking model had not been incorporated, such as Bloom's Taxonomy, and if this was not established then how were students to think critically? Further, the realization that the right questions were not being asked led to the conclusion that higher order critical thinking skills were not being integrated in the SI sessions. Finally, SI Leaders

offered the majority of the explanations and provided less practice for the students, which was in direct conflict of allowing students to think critically.

Prior to this investigation, the assumptions and perceptions were based on data. Because of the convergence of these assumptions with perceptions, it was theorized that critical thinking throughout the SI program was being promoted. It was an error to assume that SI Leaders understood critical thinking and how to incorporate it (Yeh, 2009). Through critical thinking research, it was found that not all SI Leaders understood the full meaning of critical thinking and its impact on students and their learning and thus most were not reaching a higher order level of thinking. Just asking questions was not sufficient. Questions must be constructed correctly according to Bloom's levels to elicit the correct response. Higher order skills, such as analysis and synthesis, are often needed for critical thinking to occur (Halpern, 1998). SI Leaders sometimes struggle with crafting good critical thinking questions that get at the heart of the problem and challenge thinking.

Encouraging peer-to-peer interaction and student learning furthers this enhancement of critical thinking skills and comes full circle with student independent practice (Halpern, 1998; Yeh, 2009). This process is in direct correlation with Paul (2011) who stated that to have critical thinking one must have explicit instruction, using a specific model for critical thinking, and providing instruction and practice using that model in how to think critically. SI sessions that can focus on application and practice of critical thinking through strategies used by the SI Leader and practiced by the students should support the Paulian theory that explicit instruction improves student performance and knowledge. It should also be noted that these three steps should occur in order; for instance, students cannot practice critical thinking if they are not given a model to use.

Conclusion

Not all courses offered the opportunity for higher order critical thinking, not because of the course but due to the lack of pedagogical knowledge and planning by the SI Leader. SI Leaders needed to incorporate Paulian's three-fold process of critical thinking (telling

the students they will be thinking critically, using a specific model, and providing instruction and practice). Yeh (2009) supports this type of direct-instruction model of incorporating pedagogical skill for critical thinking. Online communities that use collaboration can enhance the effectiveness of e-learning integration. SI is one such type of online community that not only offers the chance for learning collaboration but also provides a social community (Ashwin, 2003). However, students need to be encouraged, held accountable for their learning, and allowed the opportunity for reflection in order to have critical thinking skills learned (Yeh, 2009). Such integration is necessary for students when it is expected that they will use these skills for future courses and in everyday life (Maclellan & Soden, 2012).

This case study imparted a perception versus reality check; the perception was that critical thinking was occurring in online SI, based on data and student self-assessments, but in reality, it was not. Further, through observations, it was realized that hard data did not offer a complete picture; the qualitative nature of the observations revealed that measuring the construct critical thinking needed to be evaluated through observations. As a result, training on what critical thinking really is and how to integrate it into the online SI program will be developed and implemented.

The lessons learned from this investigation created short and long term plans for the online SI program. First, end of course evaluations needed to change to reflect appropriate verbiage. The questions were not explicit for the students, and purposeful questions were not being asked; this explains why students answered so strongly that they were learning critical thinking skills. Also, the critical thinking survey questions needed to be revised to alleviate possible misinterpretations of defining critical thinking. Because observations offer critical value, it was recognized that a self-observation form was necessary for SI Leaders to reflect on their own sessions.

While research has been able to show that SI consistently establishes a positive impact on student performance (University of Missouri, 2007), less research has investigated online SI as well as critical thinking in an online SI program. This investigation not only helped fill that gap but also changed the SI Leader paradigm from imparting knowledge to providing direction for critical thinking skills.

References

Ashwin, P. (2003). Peer facilitation and how it contributes to the development. *Research in Post-Compulsory Education, 8*(1), 5-18.

Clark, D. (2010). Bloom's taxonomy of learning domains: The three types of learning. *Big Dog & Little Dog's Performance Juxtaposition.* Edmonds, WA: Author. Retrieved from http://www.nwlink.com/~donclark/hrd/bloom.html

Elder, L. (2010). *Richard Paul Biographical Information.* Retrieved 2012, from The Critical Thinking Community: http://www.criticalthinking.org/data/pages/37/ff640b6d016307b54cad91e5a9d4edfd4f18adb74215a.pdf

Facione, P. A. (2011). *Critical Thinking.* Retrieved from What it is and why it counts: http://www.insightassessment.com/CT-Resources/Independent-Critical-Thinking-Research/pdf-file/Critical-Thinking-What-It-Is-and-Why-It-Counts-PDF/(language)/eng-US

Facione, P. A. (1990). *Executive summary: Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction.* Millbrae, CA: The California Academic Press. Electronic version retrieved from http://www.insightassessment.com/pdf_files/DEXadobe.PDF

Halawi, L. A., McCarthy, R. V., & Pires, S. (2009). An evaluation of e-learning on the basis of Bloom's Taxonomy: An exploratory study. *Journal of Education for Business, 84*(6), 374-380.

Halpern, D. (2003). *Knowledge and Thought: An Introduction to Critical Thinking* (4th ed.). Hillsdale, NJ: Routledge.

Halpern, D. (1998, April). Teaching critical thinking for transfer across domains: Disposition, skills, structure training, and metacognitive monitoring. *American Psychologist, 53*(4), 449-455.

doi:10.1037/0003-066X.53.4.449

Huitt, W. (2011). Bloom et al.'s taxonomy of the cognitive domain. Educational Psychology Interactive. Valdosta, GA: Valdosta State University. Retrieved [date], from http://www.edpsycinteractive.org/topics/cognition/bloom.html

Krathwohl, D. R. (2002). A revision of bloom's taxonomy: An overview. *Theory into Practice, 41*(4), 212. Retrieved from http://search.proquest.com.library.capella.edu/docview/218799120?accountid=27965

Maclellan, E., & Soden, R. (2012, May). Psychological knowledge for teaching critical thinking: The agency of epistemic activity, metacognitive regulative behaviour and (student-centred) learning. *Instructional Science, 40*(3), 445-460. doi:10.1007/s11251-011-9183-4

Malm, J., Bryngfors, L., & Mörner, L.-L. (2012, November 4). Benefits of Guiding Supplemental Instruction Sessions for SI Leaders: a Case Study for Engineering Education at a Swedish University. *Journal of Peer Learning, 5*(1). Retrieved from http://ro.uow.edu.au/ajpl/vol5/iss1/1

Paul, D. R. (2011). Critical Thinking: Many Things to Many Persons. *31st International Conference on Critical Thinking*. Berkeley.

Paul, D. R. (2008). How to Teach Students To Seek The Logic of Things: To Dissolve Wholes into Parts, Unite Parts into Wholes, Question, Infer, and Reason to Purposeful and Creative Ends. Foundation for Critical Thinking. doi:ASIN: B004XD7KMG

Petress, K. (2004). Critical thinking: An extended definition. *Education, 124*(3), 461-466.

University of Missouri, Kansas City (2007). *Supplemental Instruction (SI) National Data: Fall 2003-Fall 2006*. Retrieved from http://www.

umkc.edu/cad/si/si-docs/National-Data-SI-2003-2006.pdf

Yeh, Y.-C. (2009, March). Integrating e-learning into the Direct-instruction Model to enhance the effectiveness of critical-thinking instruction. *Instructional Science, 37*(2), 185-203. doi:10.1007/s11251-007-9048-z

Appendix A
Critical Thinking SI Observation Form

SI Leader Name: _____

Course Name: _____

Program Level: □ Graduate-Level □ Upper-Level Undergraduate □ Lower-Level Undergraduate

Course Type: □ Quantitative □ Qualitative

		Bloom's Taxonomy *Use action verbs to describe instructional strategies.*	**Instructional Strategies** *Design explicit strategies that promote critical thought.*	**Online Tools & Techniques** *Use tools and techniques that enhancee instructional strategies.*
Higher-Order Thinking	Graduate-Level	Level 6 Evaluation		
		Level 5 Synthesis		
	Upper-Level Undergraduate	Level 4 Analysis		
Lower-Order Thinking		Level 3 Application		
	Lower-Level Undergraduate	Level 2 Comprehension		
		Level 1 Knowledge		

Appendix B

Paulian Theory	Cognitive Ability	Bloom's Taxonomy
Gather *relevant* information • Generate purpose • Raise questions	• Clarifying issues, conclusions, or beliefs • Questioning deeply: raising and pursuing root or significant questions • Practicing Socratic discussion: clarifying and questioning beliefs, theories, or perspectives • Reading critically • Distinguishing relevant from irrelevant facts	Knowledge Comprehension
Make *logical* inferences • Use information • Utilize concepts • Make inferences	• Comparing and evaluating perspectives, interpretations, or theories • Comparing analogous situations: transferring insights to new contexts • Generating or assessing solutions • Refining generalizations and avoiding oversimplifications • Making plausible inferences, predictions, or interpretations	Application Analysis
Generate *justifiable* assumptions • Make assumptions	• Giving reasons and evaluating evidance and alleged facts	Analysis
Follow out implications *logically* • Generate implications • Embody point of view	• Noting significant similarities and differences • Thinking precisely about thinking: using critical vocabulary	Synthesis
Check information for accuracy	• Developing criteria for evaluation: clarifying values and standards • Evaluating the cedibility of sources of information • Analyzing or evaluating actions or policies	Evaluation