# Complete Evidence- Based Practice Paper: The Impact of Information Literacy Instruction on the Synthesis Level of First-Year Engineering Students

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# The impact of information literacy instruction on the synthesis level of first-year engineering students

Abstract:

This complete evidence-based practice paper examines the impact of intentional information literacy instruction has on first-year engineering students. Information literacy (IL) is the ability to find, evaluate, and use information ethically. Many students are not taught these skills in high school, and often do not realize their deficiencies until their first year of college when they are presented with assignments requiring quality academic sources. It is crucial to reach students early in their college career to instill IL skills into their scholarly endeavors. To help remedy this deficiency, academic librarians collaborate with teaching faculty to provide IL instruction sessions to their classes, providing students with a basic introduction to the library to advanced research skills. While important to an engineer over the course of their studies and professional practice, little has been done to integrate IL to engineering curriculum.

Those studies that have examined IL, focus on the self-perceived skills of upper-division students in design courses [1]; are for a singular major course [2] or are focused on the transactional nature of IL: how to evaluate instead of the integration and synthesis of research [3,4]. Those that do examine first-year students do not tie IL to a research paper in the field-most are tied to a design project or no assignment at all. Moreover, studies do not explore IL with a diverse pool of learners, both in major and in cultural, socioeconomic and academic preparation. The study analyzes the application and perception of IL of 411 first-year students in the college of engineering at a public university. The students are from each of the ABET accredited engineering and engineering technology majors offered in the college and all were deemed academically ready for college-level English. The study used direct and indirect evidence to assess the effectiveness of the IL instruction and address the following:

Does intentional information literacy instruction impact the quality of research produced by first-year students? Does the type of intervention make a difference? The goal of the project is to not only increase students' information literacy but to move them from the content frame of IL described by Bruce, Edwards and Lupton [5], to the relational frame making the first-year students more ready to be critical of information and to see their IL skills as part of their content skills.

To address these questions, data was gathered directly and indirectly. The first source of data is a pre and post-assessment for students on self-perceived IL. As indicated by Gross and Latham [6] these are often over-inflated and not a reliable measure of students' actual IL skills. To balance this, direct evidence was collected from students. To meet the general education learning outcomes, each student completed a research paper to synthesize current research in their field addressing one of the 14 grand challenges of engineering. Each of these papers were scored on a rubric that measured the proficiency of mechanics of the paper and proper IEEE formatting, the quality, and quantity of resources used in the paper and the level of synthesis of the information. To have a more rounded picture of the impact the instruction made on student learning, the students were also asked to submit a paper completed before the IL sessions.

The instruction (except in cases where there was no instruction) was planned to follow the Association of Colleges and Research Libraries (ACRL) IL standards for science and technology. There were four different delivery methods of the IL: "one-shot" library instruction

with the engineering librarian in the classroom, “one-shot” library instruction with the engineering librarian in the library classroom, an extended three-part series in the library classroom with the engineering librarian and no instruction with the engineering librarian at all. To determine the effectiveness of the instruction, various statistical techniques including ANOVAs were completed to compare the gains in perceived skill, as well as to compare the scores across sections of the synthesis paper.

Introduction:

The field of engineering is constantly changing and the millennial engineering student approaches technology and information in a completely different manner [5]. Students often feel that they have a high level of IL as they enter college, but when asked about the instruction given to them many students report being self-taught [6]. This study looks at multiple methods of IL instruction in a first-year experience course for engineering students and other students seeking to complete their general education requirements.

IL skills are often looked upon as assumed knowledge in college students. It is unfortunate that many students, and instructors, realize this gap in knowledge during a senior design project. Many engineering programs assume that it is the role of the English department to teach such skills. This approach however, does not provide context for the student, nor does it address formatting requirements and skills that are unique to the field of engineering. Students must be able to find, evaluate, and use information ethically to allow synthesis of information. It is crucial to reach students in their first year of college to develop IL skills and a strong level of synthesis into their matriculation. To help remedy this deficiency, academic librarians collaborate with teaching faculty to provide IL instruction sessions to their classes, providing students with a basic introduction to the library to advanced research skills. While important to an engineer over the course of their studies and professional practice, little has been done to integrate IL to engineering curriculum.

Research Questions:

Does intentional information literacy instruction impact the quality of research produced by first-year students? Does the type of intervention make a difference?

To operationalize these questions, the level of synthesis, quality of citations, as well as the writing conventions were examined. The writing convention would be the primary level of IL in the instruction. Can students use proper formatting and write a foundational piece of research. The quality and quantity of the citations, as well as their level of relation to the topic shows a deeper level of understanding and implementation of the IL instruction. The synthesis level of the paper shows that the students have fully applied the IL instruction and made the learning personal.

Theoretical Frame:

The purpose of the IL instruction is at the crux of the theoretical frame. Bruce, Edwards and Lupton [5] define six frames for IL: the content frame, the competency frame, the learning to learn frame, the personal relevance frame, the social impact frame, and the relational frame. Each of these frames examine the purpose of the IL instruction. The majority of IL instruction within the content area exists in the content and competency frames. These frames look at the discreet skills of IL and how they can be applied to the body of knowledge in the discipline. The content

frame examines the information available to students, whereas the competency frame is performance driven. Both of these views on IL are often assessed with a recall assessment, of little synthesis. These frames require little, if any, synthesis by students and the information is given in a top down manner (from instructor to student).

The purpose of the instruction was to move the IL from these frames to the more complex, synthesis driven personal relevance and social impact frames. The personal relevance frame focuses on the learner developing as an expert on a topic important to them [5]. This makes the IL personalized and allows the skills to expand past the assignment. The social impact frame looks at how IL can inform social issues and problems in the field. This also empowers the learner to personally connect with the literature and be critical of the methodology and findings. The instruction was devised with the purpose of a critical lens in mind and gave students the opportunity to explore the information available and the assignment asked the students to think critically about their chosen field of research.

Literature:

IL is a critically overlooked by many students and instructors alike. In the field of engineering, this endeavor takes on a whole new ripple; how do you show students that a degree that can seem largely transactional in the first year, needs to be paired with deep synthesis and information seeking? Perceptions of students, as well as faculty must be adjusted to understand the importance of IL and ensure that it is not left to the English department, or self-learned skills without rhyme or reason.

IL Instruction in Higher Education

Theories about IL instruction vary by in large based on the purpose of the instruction. Wang [7] found that in order for instruction to be impactful for students and instructors alike, the instruction must be tied to an assignment. This leads to the approach that you are fulfilling a request for a client instead of a one off lesson. Not only must this instruction be tied to a specific purpose, it must be well planned and relevant to the student, approaching them at an appropriate level. Wang notes that “[s]etting clear intentions and objectives in an important part of curricular development and lecturers need to know the broader educational context as well as their specific teaching context” [7, p. 10]. With a purpose and intention in mind, instructors need to be cognizant of the assessment methods employed to measure the effectiveness of instruction. Mounce notes that information about effectiveness of IL instruction in the field of engineering can often be narrative, this could have to do with the fact that the purpose of the instruction was to improve a paper, not to make the students more proficient in their literacy [8].

When IL is the goal on the instruction, Gross and Latham [6] found the results of pre and post-self-assessments are often not a good measure of IL skill. This is especially true in first-year students. While their study showed a perceived improvement of IL skills, the level of skill professed did not match the actual demonstrated skills of students. The study supports the conclusion that many students enter college grossly unprepared in the field of information literacy and unaware of this deficiency. Gross found the 90% of entering freshmen entered at a less than proficient (65%) level.

## IL in the Field of Engineering

Many who approach IL in the field of engineering approach the task by integrating it to the engineering design cycle. Fosmire, found that using the engineering design cycle as a conceptual model for IL was a way to bring together engineering education, and the library community [3]. This model make the IL instruction a discrete set of steps with the design cycle calling for appropriate resources at each phase of the design process. The paper does however, point to the fact that outcomes for both students and instructors must be clearly defined. The defined outcomes is supported by Kerins, Madden and Fulton who found that engineering students have an overreliance on the internet and code manuals for their information as opposed to their peers, in particular those in law [1]. The study looks at upper division students and their information seeking habits. The study examined students who had a tour of the library during their first year orientation and found that students often relied on the internet for research and that the library was not the first place information was gathered. The study also points to the understanding that both students, staff and faculty need specific training to make IL instruction effective for engineering students.

Phillips and Zwicky [2] and Ali et al [4] both examine the impact of IL instruction with upper division engineering students with different measures. Phillips and Zwicky examined self-assessed information literacy skills of one upper division course. They found the perceived skills in patent searching as well as IL general search techniques were improved after specific instruction [2]. These results point back to Gross and Latham and overestimated IL skills of students. Ali et al [4] used a more direct measure to gauge the impact of IL instruction in upper division engineering students. They look at the search strategies and perceived quality of documents. These measures, while more direct, are still very transactional in their approach.

## IL in First-Year Engineering Courses

Intervention in the first year of college is imperative to improve student outcome in subsequent years. Wertz et al found the students in their first year design class who received no instruction were over reliant on web sources for information [9]. Their analysis of student documents also found that there was insufficient evidence offered to support claims in the students' research. The multiple facets of the analysis points to a lack of quality, quantity and synthesis of research in first-year students who do not receive IL instruction. Feldmann and Feldmann showed that first year engineering students who received IL reported being more aware of library resources and said they felt the instruction was worthwhile [10]. To build on these finding, Wertz et al, found the increasing library instruction in first year engineering courses from 10 minutes to 45 over the term of a course, increased the quality of sources used by students, decreasing the use of websites for information [9]. These studies both examine the transactional nature of IL instruction in the first year engineering classes, not the synthesis of these skills.

One approach that many universities take to infuse IL skills in students is online tutorial modules. This provides a flexible method for delivery of content and keeps information readily available for students. Roberts and Bhatt, used a self-assessment of IL skills in first year engineering students to measure the impact on online tutorial IL videos paired with individual consultations with the librarian. They found that students and faculty both reacted positively to the instruction, but gave little tangible evidence as to the extent the instruction was impactful [11]. With a little more specifics, Palmer and Tucker measured the level of ability of first year engineering students in IL after instruction. These measurements focused on the transactional

part of IL; can you identify a source [12]. They found that the online tutorial methods had a larger, more positive impact on those living on campus who regularly visited the library.

Background:

The first-year experience course serves all freshmen in the college of engineering as well as all students as a general education elective. A typical academic year serves over 825 students. In this study, there were 411 college ready students enrolled in the course. Students who were not "college ready" in English, Mathematics or both were removed from the study to maintain a consistent study group. Of these students, 5% earn a grade of D, F, U or W. The student body of the university is diverse, with 35% of students identified as first in their family to attend any college and 54% of the university first generation in their family to receive a college degree. The first year cohort mirrors this demographic. Twenty-four percent of the first-year experience course identifies as female and 76% male, 49% of the students are Hispanic, 20% White, 4% African American, 25% Asian/ Pacific Islander and 2% other/ decline to state.

As part of the university learning outcomes and assessments, each student is required to complete a research paper in their field. The goal of the research paper is to connect students with their field, use relevant resources and IL concepts to enhance professional and personal success, and write effectively for various audiences [13]. To further support this effort, instructors developed a paper that would not only accomplish these goals, but also introduce students to IEEE formatting.

Instruction:

One-Shot library instruction: The engineering librarian met with students either in the library or in their regular scheduled classroom. The librarian gave a basic overview of IL (see below) including how to determine if a resource is credible. The librarian then showed students how to use the OneSearch feature of the library, how to request materials from other universities and how to link Google Scholar to the library database. Students were asked to compare results on Google to the results obtained in OneSearch. The instructor then followed up with students about IEEE formatting (as it was a requirement for the paper).

Series of Instruction: The engineering librarian met with the professor's first-year experience course three times throughout the semester. Each instruction session was designed to provide new information, literacy components, and scaffold among each other towards the students' final paper.

During the first session, the librarian provided a scavenger hunt in which students would work together and discover the various services provided to them from the library. This included, but was not limited to, where to check out material, the location of books and periodicals, where to get research help, and where they could study. After the students completed the scavenger hunt, they met the librarian in the computer lab for their first IL instruction session. The librarian began the instruction session by introducing the importance of evaluating sources and where they come from. The librarian utilized the CRAAP test to teach the students how to evaluate where they would be getting their information sources. The CRAAP test is an acronym used by librarians and stands for Currency, Relevance, Authority, Accuracy, and Purpose. Each of these are to help students think about their sources and if they should use them in the context of their research question.  Currency: When was the source created or updated last? Relevance: Does the

source contain information relevant to your specific research question? Authority: Do the authors have the proper credentials to publish in their field? Accuracy: Is information within the source backed up by data? Do the authors provide how they collected their information? Purpose: What is the purpose of publishing this information? Does it promote research, education, promotion, propaganda, etc?

The first session ended with the librarian demonstrating how the students could utilize the library website and find relevant sources for their paper. The librarian showed them how to use the library OneSearch. OneSearch is a search engine for the library that searches for keywords from various sources (peer-reviewed journals, trade journals, books, etc), as well as from multiple subjects. The librarian instructed the value of using library databases vs. using Google, showing the ease of finding peer-reviewed, reliable sources using the OneSearch. At the end of the session, the librarian had each student find at least one reliable source using OneSearch.

The second session with the professor's first year experience course included instruction on IEEE citation format. Prior to the course, the librarian developed an online research guide, which included information on IEEE format. The librarian went step by step with the students through the guide to show the different examples of IEEE format. The librarian also provided instruction on why it is important to cite your sources, explaining that it is not just for avoiding plagiarism and giving credit where credit is due, but it is also important to provide proper citations for future researchers who may be reading their paper and using it to continue their own research.

The third and final session with the professor's first year experience course provided students with instruction on how to write an annotated bibliography. To be considered information literate, a student must be able to find, evaluate, and cite information correctly. The annotated bibliography is an assignment that covers all three of these components. Students must be able to find good, reliable sources; evaluate the sources to consider how they would or wouldn't use them in their paper; and provide accurate citations for each source. The librarian provided an example to the class of what a proper annotated bibliography looks like.

Methods:

Of the 411 research papers completed in the semester, 50 were chosen at random: ten papers when the academic librarian did no instruction, ten papers from classes that received IL in their classroom, ten papers from classes that received instruction in the library and ten papers from classes that received a series of three instructional sessions with the academic librarian. To guard against instructor bias, ten papers were sampled from a previous year and compared to the sample (these papers had one session of instruction in the library). After the results of the first batch of papers were examined, it was evidenced that data saturation had been reached with these papers, as additional papers followed the same trend.

The papers were anonymized and graded by two independent instructors according to a common rubric (see appendix). When the results of the two scores differed (by at most one) the results were averaged if a consensus could not be found. There were only six total indicators (out of the 300 total indicators of the fifty papers) that differed by one. Students were also asked to complete a pre and post-survey gauging their perceived ability in IL. As an additional measure of the impact of instruction, a tally of the types of sources used by students in their research: Academic, Popular, News, Tertiary, Government, and Education.

Papers were scored in six different areas on a scale of 0 to 3. In line with the theoretical frame employed in the study, the rubric identifies the information literacy frame the student is experiencing. The content frame is measured in two areas of the rubric: completion and style. The completion measures the number and quality of academic sources gathered in the assignment. The style measures the language usage and the level of proper IEEE formatting in the paper. Moving to the competency frame, students were measured in three areas: evidence, writing and analysis. The evidence remarked on the relevance of each source included in the analysis. The writing demonstrated the synthesis of the material in regards to readability and overall organizational plan. The analysis category assessed the quality, quantity, and variety of sources use in the assignment. The social impact frame was measured by the level of synthesis in the paper. The synthesis looked for students who insightfully synthesize the literature and make a connection to a larger context in society and their field. A complete description of the rubric is found in the appendix.

There were a variety of statistical tests performed on the rubrics scores as well as the pre and post-survey responses to get a complete picture of the impact the IL had on student perception and performance. The pre and post-survey was analyzed with a t-test to see if there was a significant change in self-assessed IL skill. Correlation between the instruction type and each area of the rubric was conducted to give a first indication if the performance on the assignment was impacted by the instruction. After a correlation was shown, a series of ANOVAs were completed to see if there is a difference in the means for each of the instructional groups. Finally, a linear step-wise regression was completed to identify factors that predicted a student's performance and level of synthesis.

Results and Discussion:

Analysis of Student Self-Assessment:

There were a variety of data collected to create a more complete picture of the effectiveness of the IL instruction. Pre and post surveys were distributed to students to measure their self-perceived skills in IL. The bulk of the data came from the student papers. These papers were examined in two different ways. To understand the effectiveness of the instruction at a superficial level, citation types were counted. In addition, to measure if the IL moved the students between the frames of IL and internalized the instruction, papers were scored on a rubric that measured various facets of proficiency. The rubric examined six areas: if the assignment was complete; the analysis which includes the quality of sources used; the writing conventions including the ease of integration of in-text citations; selection of appropriate evidence that is good quality and related to the question; the level of synthesis of the information (a measure of changing frames) and the style which included proper IEEE formatting. These sources of data in coordination with each other show the impact the instruction has on moving students from the transactional view of IL to the relevance views of IL.

While the results of the pre and post-surveys are notoriously overstated (as discussed previously in this paper) the results are still used to give direction to future instruction in IL and ensure that students are gaining more confidence in their abilities. Table 1 below shows the averages of the pre and post-surveys and the level of significance in the differences in the mean.

Table 1 results of pre and post survey, n=195

| Question | Pre | Post | Results |
|---|---|---|---|
| I feel confident that I can explain the processes involved in the creation, dissemination and consumption of information in a variety of different formats.** | $\bar{x} = 3.642$ $\sigma = 0.7948$ | $\bar{x} = 4.371$ $\sigma = 0.5344$ | $t(73) = -7.01$ $p = 9.49 \times 10^{-10}$ |
| I feel confident in my ability to develop research questions.** | $\bar{x} = 3.7704$ $\sigma = 0.8239$ | $\bar{x} = 4.2285$ $\sigma = 0.654$ | $t(62) = -3.77$ $p = 3.6 \times 10^{-4}$ |
| I feel confident in my ability to use search strategies to find the information I need in print, library databases or the open web. | $\bar{x} = 4.0918$ $\sigma = 0.71972$ | $\bar{x} = 4.2571$ $\sigma = 0.6084$ | $t(60) = -1.48$ $p = 1.429$ |
| I feel confident in my ability to use the information I find to answer questions, solve problems or support arguments. | $\bar{x} = 4.3077$ $\sigma = 0.4203$ | $\bar{x} = 4.3143$ $\sigma = 0.3395$ | $t(60) = -1.48$ $p = .915$ |
| I feel confident in my ability to give proper credit to the information sources I use through citation. ** | $\bar{x} = 4.1377$ $\sigma = 0.7758$ | $\bar{x} = 4.3143$ $\sigma = 0.3983$ | $t(101) = -2.07$ $p = 0.04$ |

** Indicates significance at a 0.05 level

Three of the five questions showed a significant improvement, however all five showed an increase in student response as shown in Table 1 above. The three questions that showed this difference were all topics that were new to the student, like IEEE formatting. As mentioned, these results indicate that the instruction is showing an impact with students and should be continued. It should be noted that these results are not separated by number of times the student was given IL instruction.

Direct Analysis:

The bulk of the analysis comes from the student work itself. Each student submitted a paper and 50 papers were selected at random: 10 with no IL instruction, 10 with 1 IL instruction section in the library, 10 with 1 IL instruction in the classroom, 10 with 1 IL instruction that occurred in a previous year and 10 with 3 IL sessions. The comparisons of the results between papers created with IL sessions in the library and those in the classroom showed no difference. It is expected that those in the library would lead to increased use of the library later, however, that was not measured in this study. With this in mind, we used 40 of the original papers to keep the sample sizes consistent (those with instruction in the classroom were not included as they mirrored the library sessions). As mentioned, these papers were scored on a scale of zero to three, three being the highest score in six different categories. The types of references used were also tabulated by category of IL instruction.

The functional level of the IL instruction can be measured by two areas of the rubric, completeness and analysis, as well as the citation type. To compare each portion of the rubric, an ANOVA was completed and correlations were calculated.

The instruction methods correlated to each of the elements of the rubric except the writing score, as shown in table 2 below. Each element of the rubric showed a Pearson's correlation to each element, this helped to ensure that the results of the rubric are reasonable. The strong r values displayed below show the impact the IL instruction had on each of the elements of the assignment except for the writing.

Table 2 correlation matrix

| Correlation r/significance | Complete | Analysis | Writing | Evidence | Synthesis | Style |
|---|---|---|---|---|---|---|
| Instruction | .713/.000* | .834/.000* | .216/.181 | .487/.001* | .378/.016* | .520/.001* |

Since it is evident that the type of instruction correlates to the scores on the elements of the rubric, a secondary analysis is needed to determine the impact of the instruction. ANOVA tests were performed to determine if the mean score for the different areas of the rubric were significantly different across the three type of IL instruction. The ANOVAs for the completion section of the rubric as well as the analysis both show a significant difference in the means. When completion is considered across the instruction types, the results are $F(6,33)=10.484$ $p=.000$. This means that those who received more IL instruction scored higher in this area, showing a level of proficiency in the content frame of the framework.

The style indicator is the second area of the rubric that works to show student's accomplishment in the content frame. Table 3 below shows the results of the ANOVA completed regarding the style of the paper. The results $F(6,33)=2.601$ $p=0.036$ show a significant difference in the means of the three groups. As students received more IL instruction, the use of proper formatting and writing conventions improved.

Table 3 ANOVA Results Style

**ANOVA Table**

| | | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|---|
| instr * ST | Between Groups | (Combined) | 17.850 | 6 | 2.975 | 2.601 | .036 |
| | Within Groups | | 37.750 | 33 | 1.144 | | |
| | Total | | 55.600 | 39 | | | |

The competency frame is measured by the analysis, evidence and writing. Table 4 below, shows the difference in means for the different instruction types for the analysis portion of the rubric. A focus of the instruction was obtaining quality sources which is illustrated by the ANOVA as well as the citation analysis in Table 5. Table 4 shows a significant difference in the mean for the different types of instruction. The resulting $F(6,33)=18.558$ $p=.000$ show that more IL instruction lead to a significant improvement on the quality and variety of sources used for the assignment.

Table 4 ANOVA results: Analysis by instruction type.

**ANOVA Table**

| | | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|---|
| instr * A | Between Groups | (Combined) | 42.889 | 6 | 7.148 | 18.558 | .000 |
| | Within Groups | | 12.711 | 33 | .385 | | |
| | Total | | 55.600 | 39 | | | |

Table 5 Citation analysis

| Types of Sources | Academic | Popular | News | Tertiary | Government | Education |
|---|---|---|---|---|---|---|
| No instruction | 1 (1.7%) | 39(66.1%) | 4 (6.78%) | 12 (20.4%) | 1 (1.69%) | 2(3.39%) |
| One Instruction | 47(37%) | 60 (42.24%) | 3(2.36%) | 7(5.51%) | 7(5.51%) | 3(2.36%) |
| Three Instruction | 84 (89.36%) | 10 (10.64%) | 0 | 0 | 0 | 0 |

The results above in Table 5, clearly show the intentional IL instruction increases the quality of sources used by students in completing their research. The variance between the groups is 18.5 times greater than within the group, meaning that there is a significant difference in the impact of instruction on the quality of sources used.

Similar results were found with the other two aspect of the competency frame, evidence and writing. The evidence goes hand in hand with the analysis of the paper. Students with more IL instruction had a significantly different score in evidence. The results $F(4,35)=4.688$ $p=0.004$. Those who received more instruction were more critical about the evidence they were gathering and its relation to their learning. In a similar finding, the difference between the groups for writing were $F(4,35)=3.326$ $p= 0.021$. All three aspects of the competency frame showed a significant improvement as the number of IL instruction sessions increased, with the analysis showing the largest improvement of the three.

To move towards the Personal Relation and Social Impact frames, other aspects of the rubric were considered. The level of evidence gathered and used demonstrated the students' ability to critically think about the sources and their relevance to the topic. Students took control of the information gathering for this portion of the rubric.

The synthesis of the assignment moved students to the social impact frame. The assignment called for students to examine a problem, look critically at that problem and report out how their field is working towards an end goal. The writing as well as synthesis aspects of the rubric show how students are not only linking ideas together, but being critical of research and findings. Both these elements showed a difference of the means when an ANOVA was completed. For the synthesis the results were $F(4,35)=2.808$ significance 0.040. This result shows as the number of IL sessions increased, the scores on the rubric also increased.

To see if there is a causal relationship to the synthesis, a stepwise linear regression was completed. The model that emerged showed that the level of writing and the instruction were two predictors in the level of synthesis. Table 6 below shows these results.

Table 6 prediction of synthesis

| Prediction of Level of Synthesis with Instructional Factors | | | |
|---|---|---|---|
| Independent Variable | β | T | Sig t |
| Writing | 0.707 | 6.794 | <.001 |
| Instruction | 0.225 | 2.165 | .037 |
| R= .786<br>$R^2$=.618<br>F=29.991<br>Sig F<.001<br>N=39 | | | |

These results suggest that 61.8% of the variance in the level of synthesis demonstrated by students can be attributed to the writing level (β=0.707) of the students as well as the instruction (β=0.225) with the writing being the strongest indicator.

Final Thoughts:

In the case of IL instruction, more is more. The results show that a sustained series of IL instruction over the term increase students' proficiency in research as well as help them to move to the relational frame of IL. An intentional partnership between the academic librarian and instructor as well as a well-designed assignment with the intention on illustrating proficiency in IL is critical to support first year students as they matriculate. The results show that increasing the number of IL sessions, improved every aspect of a students' paper and made them a more critical consumer of information. Moreover, the level of synthesis in a paper can be predicted by their writing style score and the number of instruction sessions. For every increase in IL instruction, the score on synthesis increased 0.225. That is to say, an increase from 1 session to 3 sessions increases the synthesis of a paper by a full half unit. The partnership is clearly an important part of making students critical users of information and their ability to synthesis information.

Appendix 1 Rubric

| | Excellent (3) | Meets Expectations (2) | Approaching Expectations(1) | Needs Improvement(0) |
|---|---|---|---|---|
| Completeness<br><br>(Content Frame) | 6 or more appropriate sources (academic, government or education) | 6 sources in total, 4 or more are academic, government or education | 3 to 4 sources that are academic, government or education | Less than 3 sources that are academic, government or education |
| Analysis<br><br>(Competency Frame) | A variety of sources (peer reviewed, books, trade journals, government). All resources are of a good quality.<br><br>(all) | 4 or more academic sources from well-respected journals and government citations. Over-reliance on one type of source.<br><br>(most) | Overreliance on tertiary sources or low quality academic research: sources are not reliable. 2 or more peer reviewed.<br><br>(some) | Most sources are unreliable.<br><br>(few) |
| Writing<br><br>(Competency Frame) | Organization pattern demonstrates understanding of the topic (historical, general to specific, segments of the topic, etc.) and organizational plan enhances the presentation, promoting ease in reading.<br><br>In text citations are synthesized smoothly | Well organized but in text citations are not synthesized smoothly into the text of the paper (chunky) | Plan is inconsistent. There are no in-text citations or basic formatting makes it difficult to read. | No clear organization. |

| | | | | |
|---|---|---|---|---|
| Evidence<br><br>(Competency Frame) | All sources selected are clearly relevant to the purpose. Relevance is clearly articulated. | All sources are relevant, but the connection is not entirely clear for some citations. | The connection between the source and the topic is not clearly articulated | The relation between the source and purpose are not evident: there is misinterpretation |
| Synthesis<br><br>(Social Impact/ Relational Frame) | Summarizes and **insightfully synthesizes** the literature. There is a connection to the larger context of the field and society made by in the paper. | Summarizes the overall literature and the knowledge gained from the literature, does not draw to a larger context | Summarizes the literature but does not synthesize the information in the literature | Lacks synthesis of the literature and leave each piece as a discrete topic. There is not connection drawn between sources. Statements are unsupported by the literature |

| | | | | |
|---|---|---|---|---|
| Style<br><br>(Content Frame) | Contains no spelling or grammatical errors, demonstrates creative use of language, conscientiously follows style manual, uses quotations and citations to enhance written narrative, smooth transitions. Adheres to required length.<br><br>Proper IEEE Formatting<br><br>In text<br><br>References: proper and in order<br><br>General format: page formatting, section heading, abstract, graphics/ tables/ figures if appropriate | Contains few spelling or grammatical errors, generally follows style manual, uses quotations and citations appropriately, transitions included. Adheres to required length.<br><br>IEEE Formatting requirements are mostly followed | Contains noticeable but not distracting spelling or grammatical errors, generally follows style manual, uses quotations and citations appropriately, transitions included.<br><br>IEEE Formatting lacking | Contains numerous distracting spelling or grammatical errors, and/or does not follow style manual, and/or lacks or uses quotations and/or citations ineffectively or inappropriately, and/or lack of transitions |

Appendix 2: Additional Tables

**ANOVA Table**

| | | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|---|
| instr * E | Between Groups | (Combined) | 19.397 | 4 | 4.849 | 4.688 | .004 |
| | Within Groups | | 36.203 | 35 | 1.034 | | |
| | Total | | 55.600 | 39 | | | |

**ANOVA Table**

| | | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|---|
| instr * W | Between Groups | (Combined) | 15.313 | 4 | 3.828 | 3.326 | .021 |
| | Within Groups | | 40.287 | 35 | 1.151 | | |
| | Total | | 55.600 | 39 | | | |

**ANOVA Table**

| | | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|---|
| instr * A | Between Groups | (Combined) | 42.889 | 6 | 7.148 | 18.558 | .000 |
| | Within Groups | | 12.711 | 33 | .385 | | |
| | Total | | 55.600 | 39 | | | |

**ANOVA**

SY

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 5.208 | 2 | 2.604 | 7.985 | .001 |
| Within Groups | 12.067 | 37 | .326 | | |
| Total | 17.275 | 39 | | | |

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