The Summary-Comparison Matrix: A Tool for Writing the Literature Review

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Abstract - The literature review (LR) is a complex reading-writing task. It is arguably the most challenging and daunting element in project reports for the novice writer. Typically, the undergraduate engineering student first encounters the literature review in the capstone project. This paper shares a reading-writing tool, termed the summary-comparison matrix (SCM). The SCM is a data organizer that helps students to extract relevant information from research papers, categorize those extractions, and visualize the relationships among the disparate extractions. It is a conceptual bridge between the macro level of the LR (gathering scholarly resources) and the micro level (writing topic sentences and paragraphs). While all of our students were able to use the SCM, not many were able to produce or consistently produce viable topic sentences.

Index Terms – Capstone projects, literature review, reading-writing nexus, writing in the engineering sciences

INTRODUCTION

The literature review (LR) is a complex reading-writing, extended-performance task. For the novice writer it can prove challenging and daunting [1][2][3]. Most instructional approaches construe the LR as largely a writing task, ignoring the complex blending of both reading and writing [3][4][5]. Also, where there is writing support, it is woefully inadequate [2]. Krishnan and Kathpali [2] note that most universities provide writing support through just textbooks or in-house guides. And most LR guides assume that the writing advice they provide are broadly applicable and thus they elide disciplinary specificity.

From a teaching of language perspective the LR presents many teaching moments—at the "macro-level" (library searches and note-taking) to "micro-level" (tense, adjuncts of reporting) [3]. This paper shares a tool, the Summary-Comparison Matrix (SCM), which supports students in negotiating the "reading-writing nexus" of the LR in a capstone engineering project [3]. The reading-writing nexus, according to Dovey [3], involves the mid-level tasks that allow the writer to bridge the macro and micro levels in producing a LR [3]. The SCM is but one element in a broader framework of instructional support for writing the LR in the BSc. Electrical and Computer Engineering program offered at our university.

TEACHING CONTEXT

ECNG 3020 Special Project is the capstone course of the BSc. The project is a year-long course that contributes 20% of the final weighted GPA, which is used to calculate the award of honors.

Each project is unique and each student receives subject-matter guidance from a project supervisor. Most projects are staff-defined, and so the research problem precedes the LR to be produced by students. In this way the LR does not inform the research questions as is presumed in many LR guides. However, the student may use literature to better understand the research problem and, in turn, meet the project's objectives.

The capstone project does not necessarily produce new research work or contribute to the discipline's Body of Knowledge (BoK). Rather, it hones a range of foundational skills and knowledge in Electrical and Computer Engineering, including ethical and competent use of research and standards.

Though exceptional projects may yield a good degree of novelty, the LR in the typical project requires the student to ground the project in sound engineering practice by surveying, selecting and justifying the methods, approaches, models and standards that they use. The project tests, among other things:

- Design to specification
- Formulation of solutions to engineering problems
- Engineering analysis and enquiry
- Validation against benchmarks
- Ethical use of scholarly research
- Written and oral communication

Like faculty elsewhere, we have noted that many of our students generally produce LRs that are mere annotations of some research papers, both relevant and irrelevant [1].

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And, such annotations do not succinctly report on the germane elements of the research material—methods, approaches, models, and results. We have found, too, that often those LRs are disconnected from the rest of the report.

Each year we review and revise our teaching approach to the LR. Where resources permit, we have expanded that support to include more teaching contact and formative reviews of students' work. The most recent iteration of LR instructional support includes:

- In-house writing manual
- Workshop, facilitated by library personnel, on accessing scholarly resources
- Writing workshop on using the Chicago Manual of Style 16th edition, author-date system
- Three (3) seminars, each 1-hour long, on Research Methods in Engineering. The second of these seminar models the use of the SCM. And the third seminar requires students to return with completed SCMs, for their own projects, for discussion and follow-up instructional support
- Small-group and individual writing workshops to review draft LRs

LITERATURE REVIEW

I. Defining "literature review"

Most definitions of the LR emphasize that it leads to research novelty. Hart, for example, defines the LR as helping "to locate a gap in existing research," thus leading to a "new topic" and preventing duplication of "what has been done already" [6]. At the undergraduate level, novelty is not expected. Therefore, this is not a realistic outcome of the LR in our teaching context.

In our teaching in the engineering sciences, Creswell's [7] definition of the LR is apt. He states that the LR functions:

- To relate the study to the larger discipline
- To establish the importance of the study
- To benchmark the results of the study to other findings.

Building on Creswell's list, the LR in our teaching context grounds the work in sound engineering practice by supplying the tools and technologies, approaches and algorithms, and standards to be used in accomplishing the project's objectives.

II. The reading-writing nexus

Spivey argues that composing from sources is a hybrid literacy act, in which reading and writing co-occur: The reader is reading to write and writing shapes reading [4]. Writing from sources involves three (3) operations– organizing textual meaning; selecting textual content for representation; and connecting content cued by the text(s) [4]. Organizing, selecting, and representing are in turn shaped by "content schemata"—previous knowledge and intuition that students bring to the text that influence meaning-making; and "formal schemata"—knowledge about conventional textual organization according to the dictates of the discourse community [5].

THE SUMMARY-COMPARISON MATRIX

The SCM (see Figure 1) is a data organizer that helps students to extract relevant information from research papers, categorize those extractions and visualize how these disparate extractions are related to each other and to other elements in the report (the method and results chapters for instance). It is a visual bridge between the macro level of the LR – scholarly sources; and micro level – potential topic sentences on which to build paragraphs.

The SCM seeks to inform content schemata based on formal schemata. That is, given the content demands of the LR as a sub-genre in the capstone project, the SCM provides the categories (column headings) under which students should seek out information as they read. Simultaneously, the column headings provide a content framework for writing the LR. Therefore the matrix suggests how the LR may be decomposed into sub-sections.

Graphical organizers (GOs), most typically tree diagrams, have been used by others for LR instruction [3 appendix 1]. Such GOs emphasize the hierarchical relationship among domain concepts or content. These hierarchically organized GOs allow for categorizing literature and generating headings for the eventual LR structure.

The SCM goes several steps further. The SCM is expected to support reading-writing for the LR in the following ways:

- Knowing the formal schemata (what is expected), students can read with greater purpose. They can look for methods, approaches, etc.
- Having come across useful literature, students can summarize their findings and place these into the SCM. Their summaries, using complete sentences, provide potential topic sentences for the building out of the LR
- Having completed the SCM, students can begin comparing approaches, tools, technologies, standards, and algorithms
- Having compared texts, students can justify the tools, technologies, etc., that they eventually use in their study.

While our description of how the SCM can be used is reported in a linear way, this is only for ease of explanation, as reading, writing, and reading to write are idiosyncratic processes. In this paper we report on how students use the SCM to begin summarizing their readings.

Reference	Tools & Technologies	Approaches & Algorithms	Standards, Risk and Safety	Application & End Use	Relevance
Source#1 ***(full bibliographic detail)***	Tools & technologies used in source (1-2 sentences)	Approaches & algorithms used in source (1-2 sentences)	Standards for testing. Risks and mitigation measures in source (1-2 sentences)	Product/ application and its end use (1-2 sentences)	Significance to ECNG 3020 project
Source#2 ***(full bibliographic detail)***	Tools & technologies used in source (1-2 sentences)	Approaches & algorithms used in source (1-2 sentences)	Standards for testing. Risks and mitigation measures in source (1-2 sentences)	Product/ application and its end use(1-2 sentences)	Significance to ECNG 3020 project
Etc.	"	"	"	"	"

FIGURE 1. SUMMARY-COMPARISON MATRIX.

Generally students did not produce complete sentences to sum their ideas in the various content cells. Ten (10) students produced some complete sentences, but they did not do so consistently. Few of the sentences appeared to be viable as topic sentences, such as:

- This paper describes new technologies for underwater communication.
- A-weighting is defined by specified sound pressure levels with corresponding frequencies.
- The American National Standard- ANSI S1.25 gives the specifications for a noise dosimeter.

Seven (7) students augmented or altered the SCMs, for example the addition of "Objectives," shaded in the sample submission below (Figure 2).

The last column heading, "Relevance," produced different responses. Some students interpreted relevance to mean "significance to my study" (see Figure 2) and others "evaluation of source" (see Figure 3).

DISCUSSION

That all students were able to summarize and compare three (3) or more sources suggests that the SCM is useable. It was particularly encouraging that some students understood not just how to use the SCM but to adapt it to the unique needs of their projects. This

Reference (in Chicago manual of style)	Tools & Technologies	Approaches & Algorithms	Standards, Risk and Safety	Application & End Use	Relevance	Objective
Abdulqader, H.A., B. G. Varghese, and N. Al Nabhami. 2012. "Dynamic Short Distance Estimation Using Ultrasonics." In *Business Engineering and Industrial Applications Colloquium* (BEIAC), 7-8 April 2012	MPLAB IDE	Use of the pulse echo method	NA	NA	Code for calculation of the distance	Approach to distance sensing

FIGURE 2. EXTRACT FROM STUDENT SUBMISSION #1.

Reference (in Chicago manual of style)	Tools & Technologies	Approaches & Algorithms	Standards, Risk and Safety	Application & End Use	Relevance
Grega, W, and K. Kolek. 2002 "Simulation and Real-time Control: from Simulink to Industril Applications". In Computer Aided Control System Design – Proceedings of IEEE International Symposium Scotland UK Sept, 2002 104-109	Matlab Simulink	Software simulation in Matlab Simulink with code	Values verified in simulation and limits are set to ensure accuracy as well as safety	Technologies used to model and control systems, especially in industry	Useful

FIGURE 2. EXTRACT FROM STUDENT SUBMISSION #2.

'innovation' shows that students were not constrained by preset content categories and were able to revise both content schemata and formal schemata as they read and wrote for the LR.

From a teaching point of view, it was revealing that students did not generally nor consistently produce complete sentences in their SCMs, even though the exercise explicitly asked for these. Perhaps this task needs more modeling in the class and a class-based writing activity to better prepare students for using the SCM. Indeed a valuable output of the SCM would be topic sentences around which students can eventually write the LR.

There is also a need to define "relevance" as a content category. While students' two (2) possible interpretations – as *significance to study* and *evaluation of source* are valid, this ambiguity can confound students. One possible suggestion it to reword the category to "Relevance to Project," which should help clarify that the students need to make clear links between the LR and the rest of the study. What would be then inferred is that because the source is relevant in a specific way to the project, then it is also "useful."

Completed SCM provide a conceptual map that faculty can review and provide formative feedback ahead of writing of the LR. This allowed for timely intervention with students who are having difficulty with the LR. The language instructor intervened to:

- Examine application of citation style
- Assess use of language
- Model the writing of topic sentences, building paragraphs and linking the paragraphs

The project supervisor, as the subject-matter expert:

- Reviewed for completeness of content coverage in the LR
- Assessed the quality and relevance of sources used and advised the student as needed
- Checked the selected methods, models, algorithms, etc. for fitness for purpose

CONCLUSION

The SCM has proven useful to our teaching practice, in so far as it provides a framework for meaning-making as students read for and write the LR. It compels students to make visible and concrete how scholarly material will be used to meet the objectives of their capstone projects, and ultimately how their projects are informed by sound engineering practice.

We will continue to use the SCM across cohorts, allowing for refinement of the SCM itself and for honing the language instruction that supports it.

The ultimate value of the SCM lays in its ability to help students build effective LRs and forge links to other parts of the report. In a forthcoming paper we will describe how we have scaffolded writing using the SCM to produce the eventual LR. And we will track students' use of the SCM across the writing of the report.

Finally, we believe that the SCM is adaptable and can be configured to meet the LR needs of capstone projects in engineering disciplines other than electrical and computer engineering. This would provide opportunities to test its utility in varied discourse communities.

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