An Extendable Process Guide for Scientific Literature Research

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Master-Thesis

don / presented by
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Abstract

Scientific Literature Research is conducted to learn about a new domain. It helps researchers to understand the different facets, their inter-dependencies and the underlying fields of the domain at hand. However, for an inexperienced researcher, choosing the right technique, database, application and finally an appropriate combined-process requires research of its own. This might take the focus away from the actual research. To solve this problem, the aim of this thesis is to propose an overall process or workflow that will help researchers, especially inexperienced researchers in performing literature research. I have proposed a process called the Unified Literature Research Process (ULRP). This process has been derived from the research conducted in four directions, i.e. 1. Existing Literature Research methodologies of Literature Research; 2. Models and Standards of “Information Literacy” proposed by different countries; 3. Individual and Institutional Guidelines for performing Literature Research; and 4. Guidelines for performing Literature Research published in scientific and academic capacities. Subsequently, ULRP must be propagated in a university-setting. Thus, the Process Guide tool has been implemented. The tool is a web application built for RWTH Aachen University so that the students can utilize it for performing and tracking their Literature Research. The process guide tool is also extendible, i.e. it enables the course coordinators to modify the process before offering it to the students.
Acknowledgements

First and foremost, I would like to express my sincere gratitude to my advisor Mr. Christoph Greven for his continuous support, patience and feedback throughout this thesis. I am also grateful to Prof. Dr. Ulrik Schroeder for this opportunity.

I would like to thank my mother and father for being my support system. My special thanks go to Vinay, Savitha, John Jack and Amar for their perpetual support throughout this thesis. Finally, I would also like to thank everyone who took part in the evaluation process.
Chapter 1

Introduction

Learning new things especially without context and prior experience can be a daunting task. While venturing into a new domain, particularly in academic research such as for writing a research paper or documenting the state-of-the-art of any academic discipline, scientific literature researches are conducted to achieve a sound understanding of the domain at hand. Different literature research processes can be undertaken to familiarize oneself with the new domain. There are diverse types of literature review methods that can be undertaken. Researchers usually pick one or a combination of the different techniques of conducting research to learn about the domain and produce results. A seasoned researcher might have perfected his or her own research process over the years. But, an inexperienced researcher or a beginner, needs guidance to not be overwhelmed by the possible research techniques. An inexperienced researcher in the context of this thesis is anyone who has trouble proceeding while performing literature research. Mainly, students who are beginning to learn on their own, either in the context of self-development or writing a seminar paper or thesis etc., can also be termed as inexperienced researchers. Furthermore, a process with predetermined number of steps that can be used for literature review process can be termed as a guided process.

To dictate a guided process, we must first know the different techniques of Literature reviews available. When researching and writing about a certain topic or issue, the process used to compile and evaluate the available research is called a Literature Review. It distils the existing literature in a subject field [JeF04]. There are two main types of Literature reviews i.e. traditional reviews and Systematic reviews [AaD08]. Traditional reviews begin with general discussion of subject with no stated hypothesis. It will consider the gathered information in the light of a theoretical context. The theoretical context being that the aim is to find a meaningful synthesis of the findings [Nei06]. A systematic Literature review, on the other hand, starts with a clear research question, searches for relevant studies systematically. A systematic literature review attempts to identify, appraise and synthesize all the empirical evidence that meets pre-specified eligibility criteria to answer the given research question. In the end, to come up with a methodologically sound interpretation of the gathered studies [JeF04]. The traditional literature reviews and systematic literature reviews are the most commonly used types of literature reviews. They have clear definitions and are meant to be done in stages.

When a written literature report is involved, the traditional literature research process can also be called a Narrative literature review. These types of review articles do not list the types of databases and methodological approaches used to conduct the review nor the evaluation criteria for inclusion of retrieved articles during the search of the databases. The focus remains on writing the report for the research conducted. Based on the type of data used, the logic employed and the method of analysis, literature research methodologies can be divided as Qualitative and Quantitative methods. While the type of data for Qualitative is unstructured and textual, Quantitative has structured and numeric
data. The logic employed for Qualitative is inductive and that for Quantitative is deductive. Inductive logic is when the conclusion is derived from previous knowledge and Deductive logic when the conclusion is drawn from general laws. The method of analysis for Qualitative is interpretive and that for Quantitative is statistical [Baz02]. Rapid Structured Literature Reviews (RSLR) is another methodology which is used to summarize and synthesize research findings within a given timeframe [AaD08]. The whole methodology is mainly divided into three stages i.e.

1. Conceptualization: Introduction and Scope
2. Organizational Aspects: Finding the main research methodologies and finding the extent of the literature
3. Sense Making: Discussions and Conclusions

Argumentative Process reviews and scrutinizes representative literature and accepts or refutes the hypotheses mentioned in them. Integrated reviews, scrutinizes, and incorporates representative literature on a topic in a blended way to generate innovative ideas and frameworks. Methodological review focuses on what methods were used for the literature research and helps in gaining a detailed understanding in a theoretical and substantive level [Har98]. Historical reviews are focused on surveying research throughout a continued timeframe, starting with the first time an issue, concept or problem first emerged in the published media or an academic setting [GBG96].

While learning a new domain, researchers resort to the literature research process. The main tasks in a literature research process are as follows [Ran09]:

1. Delimiting the research problem
2. Demarcating the research categories
3. Seeking new directions in future research
4. Seeking support for existing knowledge
5. Only employing productive methodologies

To perform these tasks, experienced researchers have perfected their own processes of literature research to suit themselves. But when inexperienced researchers try their hand at this, they could be lost due to the various aspects involved. When sorting through mounds of literature pertaining to a new domain, an inexperienced learner might usually feel lost or overwhelmed. They are usually unable to proceed without any guidance. Guided processes can be better for learning new material and performing tasks that relate to the newly acquired information. When beginning scientific research, literature research is often the first step. The type of literature research methodology to use, the number of steps to include in the chosen methodology are not fixed. Different organizations and individuals have adopted methods that have suited them. A unified process that will adopt the best features from different processes and guidelines must be created.
The main aim of the thesis will be to come up with a unified process of performing literature review that will cater especially to inexperienced researchers. To propagate this process, a digital solution must be provided so that the literature research process can be tracked by the inexperienced researcher and not feel overwhelmed by the entire process.

Analysis of the existing work that will adapted into this thesis is explained in Chapter 2. The conceptual approach of the entire process that will be proposed is discussed in Chapter 3. The introduction and explanation of the process that stemmed out of the research is done in Chapter 4. The implementation of the digital solution for the process is explained in Chapter 5. The evaluation of the implemented tool is done in Chapter 6. The thesis is concluded in Chapter 7 and the potential future work will be discussed.

Please note that literature review and literature research will be used interchangeably during this thesis. Although they are almost the same, the key difference is that at the end of literature review, a written report expected with results and the research is more for the understanding.
Chapter 2
Related Work about Proposed Guided Processes for Scientific Literature Research

There have been many efforts in the research community to design an ideal scientific research process. In fact, the efforts have not just been in scientific capacity. Individuals and organizations that do not just pertain to information technology have also contributed to that wholesome research process. In this section, an overview of all the processes, guidelines, standards and models already incorporated in many dimensions of research have been described. This section has two main divisions. Firstly, there are guidelines and processes that are in place. Secondly, there are standards, models and processes that originated out of these, all published with scientific merit. This section will have further subdivisions of the publications of scientific merits and scientifically published capacities, as opposed to individual articles and guidelines by institutes, for their employees. After describing and summarizing the state-of-the-art in the literature available, for both the “Processes and Guidelines” section and the “Standards and Models” section, I will analyze the available information in a horizontal schema that will get me one step closer to defining a process.

The horizontal schema in this thesis is prepared in two phases. Phase 1 is to group the different steps in the resources according to their similarities vertically. Phase 2 is imagining the different grouped-steps, as if they were a part of one single horizontal workflow. For example, if Entity 1 has steps A, B, C and Entity 2 has steps A1 and C1. Then, due to the similarities between A1 and A as well as C1 and C, the schema will have three steps, i.e.

1. A2 (combination of A1 and A)
2. B
3. C2 (combination of C1 and C)

2.1 Processes and Guidelines that Illustrate Literature Research Processes

This section aims at providing an overview of some of the commercially used, scientifically published, internal guidelines and processes of institutions and individuals. These entities somewhat describe a process for scientific literature research.
2.1.1 Research Publications for Full Processes

Conceivably, the simplest framework proposed for literature review process is by Levy et al. [LeE06] which stems from Bloom’s Taxonomy. To classify intellectual skills and abilities, Benjamin Bloom [Beb56] introduced the Bloom’s Taxonomy. His system described six cognitive levels: knowledge, comprehension, application, analysis, synthesis, and evaluation. Figure 2.1 depicts the six cognitive skills as a developmental arrangement. It has been used in a classroom setting since the time of its proposal to measure the student’s learning and capability to learn in the form of a developmental process. In the end, the student would have to interpret and propose his/her own point of view regarding the domain that was being studied.

![Figure 2.1: Depiction of Bloom’s Taxonomy [Beb56]](image)

Levy et. al [LeE06], thus, proposed a framework that follows the systematic data processing approach which is comprised of three major stages. The first step is gathering resources and screening them based on the requirement. The second step, i.e. processing stage uses the Bloom’s system to understand the resources gathered. Finally, the third stage involves using the interpreted content and writing a literature review report. The main stages are summarized below:

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>inputs</td>
<td>literature gathering and screening</td>
</tr>
<tr>
<td>processing</td>
<td>following Bloom’s Taxonomy</td>
</tr>
<tr>
<td>outputs</td>
<td>writing the literature review</td>
</tr>
</tbody>
</table>

Table 2.1: Processing stage of the framework based on Bloom’s Taxonomy [LeE06]
Grant et. al [GrB09] introduced the Search, Appraisal, Synthesis and Analysis (SALSA) framework to review some research methodologies. The framework itself with their outcomes can be considered as a guided literature review process. The steps of the SALSA framework are as follows:

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search</td>
<td>Research scope of all papers</td>
</tr>
<tr>
<td>Appraisal</td>
<td>Keeping relevant papers</td>
</tr>
<tr>
<td>Synthesis</td>
<td>Extraction relevant data</td>
</tr>
<tr>
<td>Analysis</td>
<td>Review Results</td>
</tr>
</tbody>
</table>

Table 2.2: Steps of the SALSA Framework [GrB09]

Mujtaba et. al [MPF08] proposed a systematic mapping process to create a final systematic map from the available research material in the field of software line variability. Each process step has an outcome, which is the incoming resource for the next step and the overall outcome of the process is the systematic map. Figure 2.2 shows the mapping process.

A guide for writing literature reviews for medical students [Pip13] proposes the following guidelines:

1. Generating a Hypothesis
2. Searching Literature (what to search and where to search)
3. Managing your findings
4. Interpreting your findings
5. Structuring the review

Ebrahim [Ebr12] proposed an elaborate process for literature review with guidelines for searching and screening the literature itself. The steps are:

1. Identifying key terms to look for literature
2. Locating literature with the help of keywords in relevant databases
3. Critically evaluating the literature
4. Organizing the literature in categories by creating notes and representation diagrams about it

2.1.2 Research Publications for Targeted Steps in the Process

In the process of literature research, reading a lot of literature is a crucial step, so is picking the search methodology. In my research, I found a string of relevant literature that are providing guidelines or frameworks for organizing the actual literature and others also focused on several targeted sub-steps of the processes.

Some of the processes try to answer the vital question i.e. “Why?” Why does one need to perform literature review? This is done as a pretext to the entire process. Levy et. al [LeE06] answer the “Why?” in three points:

1. Building a solid theoretical foundation for one’s research or study
2. Fitting the literature into your research
3. Place your study in the context of existing state-of-the-art

Another attempt at answering the question “Why?” is in [Ske14]:

1. To discover the state-of-the-art
2. To determine the relevance of each literary resource
3. Understand the relationship between the various contributions and hence resolve ambiguities

Levy et. al [LeE06] also focus on the search methodologies based on the combination of the authors and the resource together with keywords. Firstly, they introduce the phases of searching i.e.

1. Identify Literature databases and electronic resources
2. Where to search?
3. Identifying keywords
4. What to search?

Then, they progress with the classifications i.e.

1. Backward searches
2. Forward searches

Each of these have two sub-types in them i.e. “authors search” and “references search”. Initially, they define what a keyword search is. “Keyword search refers to querying of quality scholarly databases using a specific word or phrase (i.e. “keyword”) when attempting to find relevant literature [...]” [LeE06]. With this definition, we can now begin to define the rest of the sub-types with examples. Visualization of each of the sub types with the help of examples are depicted as figures. Overall, backward search refers to
searching using the references and the authors of a particular resource at hand. For example, a particular resource from a keyword search was found by a researcher, then looking at all the resources in the reference section of that resource is called backward reference search and looking at the previously published work of the authors of that resource is called backward authors search. Figure 2.3 shows an example of a backward reference search. For example, a researcher found a resource which fits the research topic exactly and it has references shown in Figure 2.3, locating and reading these resources is called backward reference search. Figure 2.4 shows a backward author search, e.g. a resource matching the topic of research was found by a researcher, i.e. “Example paper” in Figure 2.4 which is authored by Dr. A. Smith. We would then try to locate and read other papers also authored by Dr. A. Smith that fit in the research topic. In addition to this, backward searches have another sub type called previously used keyword search. “Previously used keywords refer to reviewing the keywords noted in the articles yielded from the keyword search noted above [...]” [LeE06]. Figure 2.5 shows the example for previously used keyword search. If a resource that matched the research topic has keywords as depicted in the Figure 2.5, then continuing the search with those keywords i.e. Environment, Sustainability etc. is called previously used keyword search.

Figure 2.3: Example for backward reference search

Figure 2.4: Example for backward author search
Forward searches on the whole refer to searching literature that are related to a particular resource in hand, in a way that the particular resource has contributed to a new resource in some way, e.g. if a researcher found a resource from keyword search, then forward references search refers to finding the resources that are citing this resource and forward authors search refers to finding resources that are citing the author of the resource. Figure 2.6 shows a forward reference search where we see the “Example research paper” that matches the research topic is cited by another resource. That resource must be located and saved. Figure 2.7 shows a forward author search where “Example research paper 2” is written by the same author Dr. A. Smith who has written “Example research paper 1” which matches our research topic. Then we look for other papers that are citing research paper 2 that must be located and read.

To sum up, backward and forward searches are performed using the metadata of the resources [LeE06].

**References**


Another step in the research processes we have seen so far is the initial search phase. In this phase, it is important to identify terms and phases that can be later utilized for gathering resources. If there is an initial entry point or an umbrella term to start with, then, Library of Congress Subject Headings (LCSH) [R-LCH] can be used. It is a controlled vocabulary tool used for indexing, cataloguing and searching for bibliographic records in library catalogues and electronic databases. It is maintained by the Library of Congress in USA. Although it is a cataloguing tool, it can be used to generate effective keywords for search. A possible example of utilizing the LCSH in shown below in Figure 2.8. In the LCSH landing page, there are catalogue and subject headings listed alphabetically as shown in Figure 2.8. For a simple example, the research topic to be learnt is “Programming languages that are like Java”. Then one would have to navigate to the “J” file and search for “Java”. The cataloguing-terms listed for Java are “Object Oriented Programming Languages”. Then a keyword search with “Object Oriented Programming Languages” can be performed. Thus, LCSH can be used if the overall keywords or collective keywords for specific topics must be found.

Individual PDF Files: By Beginning Letter

<table>
<thead>
<tr>
<th>Numerals</th>
<th>A</th>
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<tbody>
<tr>
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<td>537 p., 3.1 MB</td>
<td>467 p., 2.7 MB</td>
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<td>602 p., 4.5 MB</td>
<td>310 p., 1.8 MB</td>
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<td>147 p., 894 KB</td>
<td>255 p., 1.5 MB</td>
</tr>
<tr>
<td>11 p., 138 KB</td>
<td>49 p., 346 KB</td>
<td>36 p., 279 KB</td>
</tr>
</tbody>
</table>
Another method to generate keywords would be with a concrete research question. This method is proposed by Canvas Libraries in University of Washington\(^1\). If the need for research has been identified, then asking a question about the scope of research or making a hypothesis can be simple. For example, there needs to be research conducted to know the link between violence amongst children and the effect of video games on this. Then one of the possible research questions would be “Are children who play video games more violent?” The guidelines proposed state that forming synonyms for the different words involved can generate possible keywords as shown in Figure 2.9. Then, trying possible combinations of the words in a search database would then yield results. From the example in Figure 2.9, the possible search phrases would be “youth and video games” and “manic video games”.

![Figure 2.9: Generating keywords from research question using synonyms](image)

2.1.3 Articles by Individuals and Institute Guidelines

Kramer et. al [KrB15] created the 101 Innovation tools project\(^2\). It was introduced to the research community for the community to receive help during the whole research process. The project covers literature research, writing, publishing and then keeping current in the field of interest. Each of the steps have specific sub-steps and each of the steps not only have the description of how, but also summaries the possible tools and aids that can be used in the particular steps. Since, the project is community-collaborated, the resulting document was the result of contributions from various researchers. Before it became a public contribution forum, there were only 101 tools and subsequently, it grew to 200+

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\(^1\) [https://canvas.uw.edu/courses/910043/pages/generating-keywords-for-successful-searching](https://canvas.uw.edu/courses/910043/pages/generating-keywords-for-successful-searching)

\(^2\) [https://101innovations.wordpress.com](https://101innovations.wordpress.com)
tools and now currently stands at 400+ tools for research aid. The main steps and the framework itself are created by the main authors. The names of the steps are as follows:

1. Preparation
2. Discovery
3. Analysis
4. Writing
5. Publication
6. Outreach
7. Assessment

However, for the scope of this thesis, only “Discovery” and “Analysis” are of interest. The formal names of the sub-steps for “Discovery” step with some of the tools (directly related information technology and general academia rather than specific field) are listed in Table 2.3 and similar information for “Analysis” are in Table 2.4. These tables help in providing an idea of the myriad of the tools that are available in the entire compilation.

<table>
<thead>
<tr>
<th>Name of sub-step</th>
<th>Tools</th>
<th>Function of Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search (literature/data/patents/code)</td>
<td>WorldCat: <a href="http://www.worldcat.org/">http://www.worldcat.org/</a></td>
<td>search books, articles and more; find holding libraries</td>
</tr>
<tr>
<td></td>
<td>Microsoft Academic Search (MAS) <a href="http://academic.research.microsoft.com/">http://academic.research.microsoft.com/</a></td>
<td>Citation index</td>
</tr>
<tr>
<td>Get Access</td>
<td>Unglue it: <a href="https://unglue.it/">https://unglue.it/</a></td>
<td>crowdfunding to make specific books freely available with CC-license</td>
</tr>
<tr>
<td></td>
<td>oadoi.org: <a href="https://oadoi.org">https://oadoi.org</a></td>
<td>detect direct access versions of articles based on doi</td>
</tr>
<tr>
<td></td>
<td>DOAI: <a href="http://doai.io/">http://doai.io/</a></td>
<td>doi resolver pointing to Open Access versions</td>
</tr>
<tr>
<td>Get Alerts and Reading Recommendation</td>
<td>SciFeeds: <a href="https://scifeeds.com/">https://scifeeds.com/</a></td>
<td>science aggregator using data from citation analysis</td>
</tr>
<tr>
<td></td>
<td>PubNiche: <a href="http://www.pubniche.com">http://www.pubniche.com</a></td>
<td>science news curation</td>
</tr>
<tr>
<td></td>
<td>Sparrho: <a href="http://www.sparrho.com/">http://www.sparrho.com/</a></td>
<td>TOC/content alerting in feed format</td>
</tr>
<tr>
<td>Name of sub-step</td>
<td>Tools</td>
<td>Function of Tool</td>
</tr>
<tr>
<td>------------------</td>
<td>-------</td>
<td>------------------</td>
</tr>
<tr>
<td>Read/View</td>
<td>Utopiadocs: <a href="http://utopiadocs.com/">http://utopiadocs.com/</a></td>
<td>PDF reader esp. for scholarly docs suggesting related literature based on what you read</td>
</tr>
<tr>
<td></td>
<td>Readcube: <a href="https://www.readcube.com/">https://www.readcube.com/</a></td>
<td>recommendations, PDF-reader, annotator, reference management</td>
</tr>
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<td></td>
<td>CrossMark: <a href="http://www.crossref.org/crossmark/">http://www.crossref.org/crossmark/</a></td>
<td>show information on the version and updates of a publication</td>
</tr>
<tr>
<td>Annotate/Tag (during/after reading)</td>
<td>Hypothes.is: <a href="https://hypothes.is">https://hypothes.is</a></td>
<td>annotating, commenting and tagging tool</td>
</tr>
<tr>
<td></td>
<td>Annotate.co: <a href="https://www.annotate.co/about.html">https://www.annotate.co/about.html</a></td>
<td>Annotate and collaborate on documents and images</td>
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<td></td>
<td>PeerLibrary: <a href="https://peerlibrary.org">https://peerlibrary.org</a></td>
<td>collaborative annotating; discovery</td>
</tr>
</tbody>
</table>

Table 2.3: The sub-steps and tools for the „Discovery“ in 101 Innovation Tools [KrB15]

<table>
<thead>
<tr>
<th>Name of sub-step</th>
<th>Tools</th>
<th>Function of Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment &amp; Collect/Mine/Extract Data</td>
<td>Dedoose: <a href="http://www.dedoose.com/">http://www.dedoose.com/</a></td>
<td>cross-platform app for analyzing qualitative and mixed methods research with text, photos and more</td>
</tr>
<tr>
<td></td>
<td>Morph.io: <a href="https://morph.io/">https://morph.io/</a></td>
<td>automated web-scraping</td>
</tr>
<tr>
<td></td>
<td>Tabula: <a href="http://tabula.technology/">http://tabula.technology/</a></td>
<td>extract data from pdf tables</td>
</tr>
<tr>
<td>Name of sub-step</td>
<td>Tools</td>
<td>Function of Tool</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------------------------------------------</td>
<td>---------------------------------------------------------</td>
</tr>
<tr>
<td>Share Notebooks / Protocols / Workflows</td>
<td>Docollab: <a href="https://www.docollab.com/">https://www.docollab.com/</a></td>
<td>Research project management and publication of experiments</td>
</tr>
<tr>
<td></td>
<td>Sumatra: <a href="http://neuralensemble.org/sumatra/">http://neuralensemble.org/sumatra/</a></td>
<td>automated electronic lab notebook for computational projects</td>
</tr>
<tr>
<td></td>
<td>LabArchives: <a href="http://www.labarchives.com/">http://www.labarchives.com/</a></td>
<td>electronic lab notebook (commercial provider);</td>
</tr>
<tr>
<td>Analyse</td>
<td>OpenRefine: <a href="http://openrefine.org/">http://openrefine.org/</a></td>
<td>cleaning and transforming data</td>
</tr>
<tr>
<td></td>
<td>Snapzen: <a href="https://snapzen.com/screen-capture">https://snapzen.com/screen-capture</a></td>
<td>collaboratively discuss / analyze screen captures</td>
</tr>
<tr>
<td></td>
<td>Synapse: <a href="https://www.synapse.org/">https://www.synapse.org/</a></td>
<td>platform for “open collaborative data analysis”</td>
</tr>
</tbody>
</table>

Table 2.4: The sub-steps and tools for the “Analysis” in 101 Innovation Tools [KrB15]

The New York University (NYU) Library provides a set of guidelines in the social work sector for writing literature reviews³. A summary of the guidelines is as follows:

1. Integration of different literature into focused work which relates to studies and research conducted in different cities, universities etc.
2. Drawing evidences and keeping away from biases
3. Presenting an overall representation of the research
4. Exclusion of contradicting studies should be avoided because showing contradicting point of views can help the overall results
5. Citing work and not just general statements

The Online Writing Lab at the Purdue University has guidelines for writing literature reviews in the social work domain⁴, they are as follows:

1. Providing overview of all content found during research

³ https://guides.nyu.edu/c.php?g=276817&p=1846105
⁴ https://owl.english.purdue.edu/owl/resource/666/01/
2. Showing the reader how one’s research fits in the current state-of-the-art of research in that domain

Warwick University proposed main ideas of literature research in a talk about hints for literature reviews. They classified literature reviews based on five different divisions, i.e.

1. Focus
2. Goal
3. Coverage
4. Audience
5. Perspective

One of the most interesting concepts in the talk is about reading and screening the available literature while performing the literature review. They talk about a straightforward process that screens the material while reading it. The idea is that the reader treats each publication as a candidate of a screening process where the publication goes to the next round of screening only after passing the current one. The criteria to passing each round is the relevance to the domain at hand. The reader first starts with the “Title” of the publication, if it is relevant, then moves on to the “Abstract”. If the “Abstract” is relevant, then the reader can read the “Conclusion” or the “Summary”. If the publication still holds, then the reader can finish the whole paper to check the relevance. It can be represented as follows:

Title → Abstract → Conclusion → Contents

University of Toronto proposed guidelines for conducting literature reviews for its health sciences department. The author devised two questionnaires, one for the conductor of the review that would act as a checklist for the next steps and one for the research material that the reader of the publication can ask themselves about the publication at hand and judge the publication against the questionnaire. The publication will be then included in the results only if it fits the questionnaire. According to the author, the conductors of the review must ask themselves questions about the research question, type of Literature review to be used, scope, information-seeking strategy, critical analysis, discussing contrary studies and relevance, appropriateness and usefulness to reader. The questions that the conductors need to ask themselves about the publications are mainly about scope, severity, relevance of the publication to the study, clear formulation of the issue in the publication, author’s research orientation, author’s theoretical framework and so on.

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6http://advice.writing.utoronto.ca/types-of-writing/literature-review/
The “Helpful information for trinity students/staff” (HITS) literature review process is a simple and easily understandable process for performing literature review. The steps are as follows:

1. Formulate a research question – Focused, specific, clearly formulated, well defined
2. Decide Keywords (Primary keywords with synonyms
3. Locating and finding studies
   1. Identifying the research
   2. Selection
4. Assessing the Literature with the following factors:
   1. Provenance
   2. Publication
   3. Evidence
   4. Objectivity
   5. Value
5. Using different search techniques
6. Always organize each step

The guidelines provided by the University Library of the American University, Washington D.C. provided a pictorial organization of a literature review. The literature review process is visualized as an inverted triangle divided into rungs where each rung’s height (in this case also can be seen as area) is the amount of importance given to the focus and the area enclosed in the rung is the amount of time spent on that particular focus. The idea is that as we progress in the process, the rungs get smaller and the focus gets deepened. Figure 2.10 describes the same.

8 https://subjectguides.library.american.edu/c.php?g=175218&p=1154337
It suggests that in the beginning, some amount of time should be spent on establishing context and background, then venturing into narrowing the focus and finally completely narrowing down the focus and content with direct relevance to the decided theme.

The Literature Bootcamp audio series provided building block steps for an effective literature review. The Bootcamp is a set of audio CDs that provide instructions on how to carry out an effective literature review. The series can be translated into a broader process of conducting literature review. The steps can be listed broadly as follows:

1. Mind-set: Replacing stress and fear of failure with confidence before performing a literature review
2. Organization: Organization of references and resources
3. Searching: Looking for appropriate resources fitting the topic
4. Reading: Reading the resources in a systematic and efficient manner
5. Writing: Writing the literature review in a way that is easy to understand
6. Improvement: Keeping current and continuously improving one’s knowledge about the field

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9 http://www.literaturereviewbootcamp.com/landing-pag/
2.1.4 Analysis of the Guidelines and Publications

Comparing and grouping all the guidelines and publications mentioned so far, a horizontal schema can be prepared. As discussed before, a horizontal schema in this thesis is created by grouping the similarities and imagining the grouped steps to be a part of a single process. Clearly, there are overlaps in the member steps in the different resources mentioned. Hence, it is possible to group the similarities and then create an inclusive group question for those steps. Out of the grouped questions, then, it is also possible to view the possible “inputs” and “outputs” to each step. An “output” of a step is nothing but a deliverable that is expected out of a step before one can proceed. The “output” or deliverable is then a prerequisite to start the next step and is hence this the “input” to that next step. However, since the inputs and outputs are intellectual tools, there is no 1:1 correlation between the output of one step and the input of next. The output enriches the knowledge of the person undertaking the process and hence the output is “altered” before it becomes the input to the next step. Table 2.5 to Table 2.12 show the grouped concepts, each group has its “inputs” and “outputs”. There are more than one instructions in the table and are sequential from left to right in one step. Also, all the main steps can be viewed as a horizontal process if the Tables 2.5 to 2.12 were to be laid out side by side.

Table 2.5 shows the first step as the result of the grouping. The grouped question is “Why?” This is the step dictates why the research needs to be undertaken and what is already known so that the researcher gets an idea of what is lacking.

<table>
<thead>
<tr>
<th>Enclosing question</th>
<th>Group 1: Why?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step Description/ Descriptive Question</td>
<td>Why start researching and what do you already know?</td>
</tr>
<tr>
<td>Actual Instruction(s)</td>
<td>Sub-step 1</td>
</tr>
<tr>
<td></td>
<td>Mind-set to perform research</td>
</tr>
<tr>
<td>Input</td>
<td>Stress/ Fear</td>
</tr>
<tr>
<td>Output</td>
<td>Confidence</td>
</tr>
</tbody>
</table>

Table 2.5: “Why?” First group of the horizontal process

Table 2.6 shows the second step as the result of the grouping. The grouped question is “Pre-How?” These are the organizational tasks and tasks that can identify an entry point of research that the researcher must perform before the actual searching can begin.
Table 2.6: “Pre-How?” Second group of the horizontal process

Table 2.7 shows the third step as the result of grouping. This group helps in identifying the possible databases to search from.

Table 2.7 “Where?” Third group of the horizontal process
Table 2.8: “How?” Fourth group of the horizontal process

Table 2.8 shows the fourth step as the result of grouping. This group explains the search process. Table 2.9 shows the Analysis and Evaluation group. After the resources have been located, they must be read, screened and categorized, so that it can be possible to draw conclusions from them. Table 2.10 is the process of reiterating i.e. repeating steps in Group 4 and Group 5 to further improve the conclusions that are drawn.

Table 2.9: “What to do with the data?” Fifth group of the horizontal process
Table 2.10: “What to do with the data?” Sixth group of the horizontal process

Table 2.11 is the group that refers to the writing aspect of the literature review process. Although, writing is not a part of traditional literature review process, a narrative literature process or even a systematic literature review process are undertaken, when a written report is expected at the end.

Table 2.11: “Writing” Seventh group of the horizontal process

Table 2.12 is the group referring to keeping current with the domain. When the research is finished, if a researcher wishes to keep informed about the developments in the domain of interest, then he/she can utilize different avenues to do so.
Table 2.12: “Keeping current” Seventh group of the horizontal process

<table>
<thead>
<tr>
<th>Enclosing question</th>
<th>Group 8: Keeping current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step Description/ Descriptive Question</td>
<td>Keeping oneself informed about the changes in the domain of interest</td>
</tr>
<tr>
<td>Actual Instruction(s)</td>
<td>Keep current with developments in the domain at interest by reading and researching by setting up alerts and recommendations</td>
</tr>
<tr>
<td>Input</td>
<td>Alerts and Recommendations in different avenues</td>
</tr>
<tr>
<td>Output</td>
<td>Current and changing information of the domain</td>
</tr>
</tbody>
</table>

The whole horizontal process can be represented pictorially in Figure 2.11. Groups 1 to 5 i.e. Tables 2.5 to 2.10 are represented in the figure. In the Figure, Group 1 is to be performed for the actual searching starts. Then group 2 and group 3 are performed. Group 6 comes next which is an iterating block that iterates over Group 4 and Group 5.
Figure 2.11: Pictorial representation of the horizontal process for tables 2.5 to 2.10
2.2 Models and Standards for Defining the Literature Research Process

This section describes the models and standards of Information Literacy (IL). A brief description for Information Literacy (IL) would be that a student who is information literate is one who knows how to secure information and use it for their learning purposes. A detailed description is provided by the models and standards. Thus, all the models and standards describe the qualities that an information literate student must possess.

2.2.1 The Steps and Instructions from Models and Standards of Information Literacy

Bruce [Bru00] introduced terminology to show the evolution of Information Literacy (IL). According to the author, the information literacy has evolved through four distinct phases. They are as follows:

1. Precursors (1980s): used some ideas in educational context
2. Experimental (1990-1995): geographically spread, more researchers experimented themselves
3. Exploratory (1995-1999): The period is marked by the exploration of different facets for IL research
4. Evolving (2000-): branching out into cross domains. The exploratory phase of IL stemmed out the following standards into what they stand to be today

Information Literacy has been an ever-changing topic with interdisciplinary research going from the beginning of early 2000’s until now. Many institutions across the globe have proposed standards and models of Information Literacy to promote learning among students and promote a lifelong learning model. A lifelong learning model is to create a continued program with the educators and the librarians in order promote learning so that the students pursue learning even without supervision and are capable to securing knowledge on their own using the different tools available [Lau06]. Thus, the Government of different countries is investing time and money in order to promote Information Literacy. In this thesis, I have picked the Information Literacy Standards and Models that were proposed mainly in North American (United States of America and Canada), Oceanic (Australia and New Zealand) and European countries (United Kingdom, Germany, Switzerland). In my research, I have not found a concrete study linking the origin of all the models and standards to each other. But, because of the proximities of these countries and similarities in governance, these models and standards were easier to group with each for the purpose of this thesis. The models and standards from these countries are perhaps the most familiar face of information literacy and provide a framework to create a learning process in schools and higher education [Moo02]. It is important to point out that there are other Information Literacy Standards proposed in some South-east Asian countries. But they are not as popular and are not cited in many publications. But, as mentioned before, the ones from the North American, Oceanic and European countries are the most cited and used in literacy programs in schools [Moo02].
The two models of Information Literacy that have been researched for this thesis are the "Information skills in higher education: a SCONUL position paper" (SCONUL, 1999) [S-SCO] and Big 6 Skills Model [S-BIG]:

1. The SCONUL model: The SCONUL Working Group on Information Literacy published “Information skills in higher education: a SCONUL position paper” (SCONUL), introducing the Seven Pillars of Information Skills model. This model adopted by teachers and librarians, contains seven main steps as the name suggests [S-SCO]. The main steps include:
   1. Identifying the need for information
   2. Identify the gaps in the current knowledge
   3. Create information-seeking strategies
   4. Locate the relevant information
   5. Review the research process and evaluate the resources
   6. Manage the acquired information professionally and ethically
   7. Present and apply the information gathered during the process of research

2. The Big 6 Skills Model: A comparable model to the SCONUL Seven pillars is the Big 6 Skills Model (Big 6) [S-BIG]. The 6 main steps are:
   1. Identifying and defining the problem
   2. Planning out the information seeking strategies
   3. Locating and gathering resources
   4. Judge the effectiveness of the resources
   5. Organize and present the result from the gained information

The different standards of IL are listed below:

1. Australian and New Zealand Information Literacy Framework (ANILF) [S-ANL]: It is comprised of five main standards. This government funded project was employed in 2003. The standards are as follows:
   1. Recognizing need for information and the nature and extent of information needed
   2. Finding the needed information effectively and efficiently
   3. Evaluation of information and the information seeking process
   4. Management of the information resources acquired
   5. Usage of the information ethically and legally
In Germany, the employed standards have two main categories. The first one is for pupils or school education and the second one is for university students or higher education. Due to the different kinds of attention needed by the two student groups from the educators, the two frameworks differ in some ways. Mainly, in the sense of magnitude of the responsibility that is placed on the student. In the framework for the university students, the need for information and the recognizing the current state of information is placed on the student which is different for the pupils, where this responsibility lies on the educators. Also, the ethical usage of the different resources is not of big interest to the student itself.

2. Standards of information literacy for school pupils (GSILS) [S-GSP]:
   1. Awareness and usage of the local information services and scientific libraries
   2. Employ strategies in order to use the aforementioned information services
   3. Efficiently securing the resources and also the usage of electronic resources
   4. Efficient evaluation of collected information and the ability to draw conclusion

3. Standards of information literacy for Higher education (GSILSH) [S-GHE]: The framework employed in the case of higher education has standards as follows:
   1. Recognizing the need for information and determining the type and scope of the information required
   2. Gaining access to the required information
   3. Evaluation of available information resources and using them
   4. Usage of technical means to present the result in target-oriented manner

4. The Information Literacy Competency Standards for Students (CILS) [S-CHE]: The Higher Education Quality Council of Ontario, Canada introduced the Information Literacy Competency Standards for Students. This framework was being used as a tool measure the information literacy in higher education. The main standards of this framework are as follows:
   1. Determining the nature and extent of the information needed
   2. Accessing the information effectively
   3. Evaluate and incorporate the gained information
   4. Acquiring and using the information ethically and legally
   5. Usage of the information to add to the knowledge base

5. The Framework for Information Literacy for students [S-ACR]: It is the standard introduced by the Association of College and Research Libraries
(ACRL) in the United States of America. The standards in this framework as follows:

1. Identification of the nature and extent of information needed
2. Acquiring the information efficiently
3. Evaluate the information seeking process and review and perfect the process
4. Usage of information ethically and legally
5. Recognizing the need to keep current with the development in their own fields

6. The Swiss Information Literacy Standards [S-SWS]: Switzerland has the Swiss Information Literacy Standards to offer. The standards are as follows:

   1. Identification of the nature and extent of information needed
   2. Usage of prior and additional information to accomplish specific purposes
   3. Acquiring the information efficiently
   4. Critical evaluation of the information seeking process
   5. Usage of the acquired information ethically and legally
   6. Management and sharing of the gained information

2.2.2 Comparison and Vertical Grouping of the Models and Standards of Information Literacy

This section provides a comparison of the models and standards of Information literacy from different countries. The differences and commonalities have been critically evaluated and abstracted in a joint vertical grouping so that all the vertical groups act as individual steps of a horizontal schema. Each step dictates the properties that an information literate student must possess in different facets of research. This information is represented in Table 2.13. There are seven steps in total that have resulted from this grouping. Table 2.13 is shown in two parts. First part depicts the first four steps and the second part has the remaining three steps. Table 2.13 contains the key aspects of the models and standards. Each standard has corresponding sub-steps, i.e. the qualities that an information-literate student must possess. These are collectively summarized below:

1. Identify: Identify the need for research and the nature and extent of research needed

   Explanation:
   1. Identify the lack of knowledge
   2. Identify the nature and extent of information needed
3. Take responsibility to gather information
4. Use existing knowledge to gather more knowledge
5. Identify diverse information sources
6. Purpose, scope and appropriateness of resources

2. Scope and Access: In the previous step, the nature and extent of information required are specified along with where to find this information. This step includes the strategic tactics required to gather the resources. This step can be viewed as a preparatory step to the main searching process. It can be thought of as the initial preparation required before the actual searching.

Explanation:

1. Identify current state of the body of knowledge
2. Physically locate search sources
3. Retrieve initially using search techniques

3. Application: Rework strategies and applying them in the process. This is the main searching process.

Explanation:

1. Depending on the previous step, formulating/revising keywords or the research question
2. Adopting search techniques
3. Summarize the main ideas to be extracted from the information gathered
4. Brainstorm all possible sources and select the best one

4. Gather: After planning the search strategies, this step includes obtaining the information required using the strategies.

Explanation:

1. Getting access to different sources
2. Usage of the previously identified diverse resources
3. Finds the relevance and usefulness of resources

5. Evaluate: Use evaluation criteria to evaluate the resources gathered from the previous steps.
Explanation:

1. Create evaluation criteria to evaluate the resources based on the kind of information required (as defined in step 1 and step 2)

2. Evaluate the resources against the evaluation criteria. Example evaluation criteria can be Quality, Accuracy, Relevance and Bias etc.

3. Filter out the resources based on the criteria

4. Reflect upon the information which is the result of the process.

5. At this point, based on the information gathered, rework the step 1 to 3, to cover any gaps

6. Manage: Consider the socioeconomic and legal repercussions of using resources

Explanation:

1. Acknowledge cultural, ethical, and socioeconomic issues related to the use of information

2. Acquire and use information and sources legally

7. Present: Presenting data acquired and sharing with community.

Explanation:

1. Use newly gained information in context of existing knowledge

2. Organize and present the summarized result from various sources and store information using appropriate methods

3. Propagate the results to targeted group if that was the intention to begin with

4. Keeping current with the changes in the field
<table>
<thead>
<tr>
<th>Name of the Standard/Model</th>
<th>1: Identify</th>
<th>2: Scope and Access</th>
<th>3: Application</th>
<th>4: Gather</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCONUL</td>
<td>Identify: able to identify a personal need for information</td>
<td>Scope: can assess current knowledge and identify gaps</td>
<td>Plan: can construct strategies for locating information and data</td>
<td>Gather: can locate and access the information and data they need</td>
</tr>
<tr>
<td>Big 6</td>
<td>Task Definition</td>
<td>Location and Access</td>
<td>Information seeking strategies</td>
<td>Access and usage of information</td>
</tr>
<tr>
<td>ANILF</td>
<td>Identify need for information</td>
<td>Find information effectively and efficiently</td>
<td>Use prior knowledge to understand new concepts</td>
<td>Find information and the information seeking process</td>
</tr>
<tr>
<td>GSILS</td>
<td></td>
<td>Local and regional library landscape</td>
<td>Gain Access to Information</td>
<td>Literature efficiently obtained Use electronic resources</td>
</tr>
<tr>
<td>GSILSH</td>
<td>Find the need and scope of the information</td>
<td>Gain access to the required information (Combined with next step)</td>
<td>(Combined with previous step)</td>
<td></td>
</tr>
<tr>
<td>CILS</td>
<td>Determine the nature and extent of the information needed</td>
<td>Access needed information effectively and efficiently</td>
<td>Critically evaluates the information sources and uses recovered information in existing knowledge (Combined with next two steps)</td>
<td>Combined with previous and next step</td>
</tr>
<tr>
<td>ACRL</td>
<td>Determine the nature and extent of the information needed.</td>
<td>Acquires needed information effectively and efficiently</td>
<td>Critically evaluate the procured information and its sources, then reiterate with new query, if required</td>
<td></td>
</tr>
</tbody>
</table>
### Table 2.13: Horizontal schema of the steps from the different models and standards

<table>
<thead>
<tr>
<th>Name of the Standard/Model</th>
<th>1: Identify</th>
<th>2: Scope and Access</th>
<th>3: Application</th>
<th>4: Gather</th>
</tr>
</thead>
<tbody>
<tr>
<td>SILS</td>
<td>Need: Determine the nature and extent of the information needed</td>
<td>Retrieve: find needed information effectively and efficiently</td>
<td>Applies prior and new information to accomplish a specific purpose</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name of the Standard/Model</th>
<th>5: Evaluate</th>
<th>6: Manage</th>
<th>7: Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCONUL</td>
<td>Evaluate: can review the research process and compare and evaluate information and data</td>
<td>Manage: can organize information professionally and ethically</td>
<td>Present Presenting the old data and newly gained data</td>
</tr>
<tr>
<td>Big 6</td>
<td></td>
<td>Synthesis</td>
<td>Evaluation</td>
</tr>
<tr>
<td>ANILF</td>
<td>Manages information collected or generated</td>
<td>Understanding and acknowledges cultural, ethical, economic, legal, and social issues surrounding the use of information</td>
<td></td>
</tr>
<tr>
<td>GSILS</td>
<td>Efficient evaluation of data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name of the Standard/Model</td>
<td>5: Evaluate</td>
<td>6: Manage</td>
<td>7: Present</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>GSILS</td>
<td>Evaluate the available Information sources</td>
<td>Take responsibility for the information usage and dissemination.</td>
<td>Present obtained knowledge effectively and contribute to community</td>
</tr>
<tr>
<td>CILS</td>
<td>Combined with two previous steps</td>
<td>Access and use information ethically and legally</td>
<td>Use information effectively to accomplish a specific purpose</td>
</tr>
<tr>
<td>ACRL</td>
<td>Use information effectively, ethically, and legally to accomplish a specific purpose.</td>
<td>Lifelong learning and recognizes the need to keep current regarding new developments</td>
<td></td>
</tr>
<tr>
<td>SILS</td>
<td>Assessment: critically evaluate information and the information seeking process</td>
<td>Responsibility: Responsible member of the academic community</td>
<td>Organization: Contribute to community in an organized fashion</td>
</tr>
</tbody>
</table>

Table 2.13 (Continued): Horizontal schema of the steps from the different models and standards
2.3 Literature Research Process Used for the Thesis

Conforming to the aim of this thesis which is defining a unified literature research process, the literature research process used for this thesis becomes relevant and the same is mentioned below:

**Step 1 – Keywords**

The search process began with keywords starting from ground up i.e.

1. Literature Survey
2. Guided Process for Learning
3. Learning Processes
4. Tools for learning
5. Process tools for learning
6. Domain familiarization
7. Learning new domains
8. Learning for inexperienced
9. Research processes
10. Scientific Workflow
11. Inexperienced research process
12. Learning for beginners
13. Research processes students

**Step 2 – Database**

Searching the keywords in the resource databases was the next step. For this purpose, a freely-accessible web-search engine, i.e. “Google Scholar”\(^\text{10}\) was used. As a result of the search process, approximately 150 results were collected. In addition to this, since different individuals have their own processes for learning new domains, it also made sense to look for articles, blogs and guidelines of independent institutions. Thus, a google search of the keywords for already adapted guidelines was also performed.

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\(^{10}\) https://scholar.google.com/
Step 3 – Reading

Reading the gathered resources (research papers) and retaining the ones that conform most to the thesis was the next step. For this step - Reading, the following screening process was used to read the gathered resources as mentioned below:

Title → Abstract → Conclusion → Content

Then, the resources were eliminated and retained as the screening process based on relevance. This step was incorporated in the search process from the guidelines from Warwick University¹¹.

Step 4 – Reiterating

After a good amount of research, it would make sense to now adapt relevant techniques from the research. Using the gathered resources, more keywords for the next round of search were found, i.e.

1. Systematic Literature Survey
2. Resource Based Learning
3. Problem based learning
4. Process based learning
5. Information Literacy

Subsequently, Steps 2 and 3 were repeated to secure more results.

Step 5 – Evaluation

After collecting the resources and subjecting them to a screening process, only the most relevant resources were retained and conclusions were drawn from them. The evaluation was based on the following specific evaluation criteria, i.e.

1. Relevance of the literature to the thesis topic, i.e., “Are the resources defining a literature process or a part of process or guidelines that can be viewed as process?”
2. Currency of the resource, i.e. “How recent is the literature?” If it is not recent, then, is it still relevant?
3. Targeted readership, i.e. “Who is the targeted readership?”; “How are they classified?”, e.g. classified based on the domain - medical, business, information science etc.; and “What is their level of expertise?”, e.g. the level of expertise in research - experienced or inexperienced researchers.

Chapter 3

Conceptual Approach for Creating a Literature Research Process

This section contains the motivating scenarios for the outcome of this thesis and the conceptual approach for securing the outcome.

3.1 Extendability of the Process

It is apparent from the related work that there are several existing processes that individuals and institutions follow to undertake literature research. It was clear that the different processes followed by different entities are aimed at similar things but, at the same time differ in some respects. Thus, it was assumed that the unified process, which would be the outcome of this thesis will be subjected to customization if it is going to be used by different entities. Hence, it was concluded that the tool will be used to propagate the process must possess customizability for the effective usage by different entities. In the context of RWTH Aachen University, the different entities can be imagined as the providers of different courses in different departments out of the multiple faculties available in the university. The tool thus, needs to provide an option to follow the process as it is or allow the different course-providers to engage in customization of the process. This preceding scenario resulted in the creation of the tool’s (process guide tool) skeleton with the L2P API from the University12 in hindsight. L2P13 is the central web-based teaching and learning platform of RWTH Aachen University. The online course-rooms in L2P offer lecturers with the tools to disseminate event-related information, provide digital materials (scripts, slide sets, lecture videos, etc.), to communicate with students, promote collaboration, assess activities, provide self-learning opportunities as well as provide feedback that enable students to manifest their own learning. For integration of the information from L2P database and the usage of L2P related features, RWTH has developed the L2P API. Since the processes need to be provided within the context of the different courses, all the courses must be incorporated in the tool using the L2P API for each user.

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12 https://www3.elearning.rwth-aachen.de/_vti_bin/L2PServices/api.svc/v1/Documentation
13 https://www3.elearning.rwth-aachen.de/SitePages/Start.aspx
3.2 The Components of the Unified Process

The unified process needed to be imagined in its atomic form. From the related work, I found out that the process followed by different entities can be broken down into steps. It is a very simple analogy where a process will have certain steps to follow. Also, in the tool it will be important to have the nomenclature decided if we needed uniformness. Hereon, I will refer to the scientific literature process as *Process* or *Workflow* interchangeably. The *Process* or a *Workflow* in the context of this thesis can be defined as the overall scientific literature process that will be followed to conduct scientific literature research. Following a simple analogy, then each of the steps in the process can also be called *Steps*. Thus, in the context of this thesis, steps can be defined as the commonly grouped activities in the *Process* that need to finish to progress in the *Process*. Inside the *Steps*, there are a set of instructions to be followed, which I have termed as *Substeps* and provide the *Methods* and *Tools* to use to achieve the *Substeps*. The *Tools* in this context is software or a list of software that can be used to conduct that step. *Method* is what needs to be done using the *Tool*. There is another term *Deliverable* which refers to the outcome of each of the *Steps*. The person conducting the literature research is the stakeholder at often and hence, deciding the completeness of the step is also up to the same person. Thus, there needs to be some measure to help the person to judge the completeness of the step. This can be measured against the deliverable. So, the question needs to be asked at the end of every step is “Is the deliverable up to par and is it sensible to proceed?” These are the atomic units in the *Process*. I will be using the defined words in the course of the thesis in *italics* to mean the same in this context and also to avoid confusion. Figure 3.1 shows the representation of the atomic units of the *Process*.

![Figure 3.1 the Process and its member components](image-url)
3.3 Possible Implementation Modules Based on the User Role

The distinct roles that had to be included in the conceptualization are “student” and “manager”. A “student” in this context with respect to the course is a user who is enrolled in the course and has no rights to make changes to the course details in any way or have a say in the supervisory decisions. A “manager” in this context with respect to the course is a user who has managerial rights for that course and can make changes to the course details. Thus, a “manager” for a course is the only kind of user who can create a Process in that course and a “student” for a course is the only kind of user who can subscribe to a Process and undertake the process and keep track of the progress. There cannot be clear separation between the Student and the Manager roles because a manager of course can be registered as a student in another course. To simulate the rights, this thesis will use a term called “Course contexts”. Basically, the tool will need to check what rights the user has with respect to one course and allow appropriate functionality in the context of each course.

Based on the role of the user, the modules that are to be considered are:

1. Manager module
2. Student module

In this context, since a manager of one course can also be a student in another one, complete isolation of the roles will not be possible. The isolation of roles needs to occur in the context of each course. This results in overlapping in the modules.

The “Dashboard” is a module where the different courses will be listed. The division of roles must be observed in each course and as mentioned before, each of the enrolled (e.g. students) and the managed (e.g. managers) courses. An overlapping can thus be observed where a user can sometimes be a “Process” creator as well as the respondent for different courses.

The manager should be allowed to perform the following tasks:

1. Create a Process and its Steps inside a course
2. Edit the created Processes and its Steps inside their managed courses
3. Choose from Process templates and make Processes from these templates inside their managed courses
4. Edit the templates to create Processes and its Steps inside their managed courses
5. View the Process and its Steps created in their managed courses
6. Access the dashboard to view course information and the existing workflows
The student should be allowed to perform the following tasks:

1. View the Processes and its Steps created in their enrolled courses
2. Undertake the Processes in the context of their courses
3. View the subscribed Processes
4. Keep track of all the subscribed Processes
5. Access the dashboard to view course information and the existing workflows in the enrolled courses
6. Decide the completeness of the Steps during the undertaking of a particular Process

3.4 Possible Implementation Modules Based on the Functionality

Based solely on the functionality of modules and not on the segregation of user roles, the modules can be as follows:

1. Identifying the user in the context of the university
2. Dashboard with courses
3. Undertaking of the Processes and the progress
4. Creation, Editing of Processes and Steps
5. Usage of templates

3.4.1 Identifying the User in the Context of the University

The L2P authentication API is an OAuth API regarding for the L2P website. It can also be used for other third-party applications. The process guide tool could utilize the L2P API to identify every user in the context of the university. The RWTH - L2P2013 API will then provide the course details for the identified user and the role information. The RWTH - L2P2013 API provides many methods to utilize the functionality of the L2P website. In the context of this thesis, the usage of all the Processes will be in the context of the university. The students will undertake the Processes in the context of the courses that they have opted for. Also, utilizing the API may allow the application to define who can create a Process and who can undertake it as well as in which context. Whereas, a role “Student” would only allow the user to undertake the Process in order to conduct the workflow.

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15 https://www3.elearning.rwth-aachen.de
literature research. The API also provides another kind of role called “Extra”, in this thesis, the role of “Extra” will also be considered as students.

3.4.2 Dashboard, Processes and Templates in the Process guide

The Process Guide tool needs to be an extendable tool. This means that the unified process can be extended to share a modified process in the course contexts. There are two facets of the extendability of the tool and they are as follows:

1. Processes can be created from scratch and be shared in course contexts.
2. The proposed unified process needs to be offered to the Process creator to be modified and used or so as to be used as is.

The Dashboard module consists of all the courses managed by the user or all the courses in which the user has enrolled already. In the context of the course, there are Processes which can be created, edited and viewed. The Steps of the Processes can also be created, edited and viewed. For the “students”, the Processes can be undertaken, and their progress in the process can be tracked. The student is responsible for deciding the completeness. The calculations based on the completion of the steps and the overall number of steps would then show the completion (as a percentage) of the Process.

The templates are the Processes to choose from and they can be edited to become Processes inside courses. The previously created Processes by the user, inside the context of a particular course, will also be available to choose as a template while creating a new Process. The templates are pre-defined Processes and their Steps that are created by the admin user of the implementation and will show up in the templates sections. It is important to note that the “templates” section is not a different section and will only be navigated through the “Create Process” section. This is because a student of one course can also be a manager (sometimes) of another course. A segregation cannot be made as there is no way to anticipate what overall role a user can possess. Also, by providing a different templates-section could confuse a user who is purely a student. The predefined templates to choose from, are the processes that emerged from this thesis and will be discussed in detail in the next chapter.
Chapter 4

Resulting Process from the Research Conducted

The Traditional Literature Review and Systematic Literature Review methodologies differ mainly in the sense that the former does not start with a research question or hypothesis. When an inexperienced researcher begins a literature review process, then formulating a research question or a hypothesis to be proved or disproved is not easy. Thus, in the community, most processes undertaken are a mixture of Traditional and Systematic Literature Reviews. A significant outcome of this thesis is the unified process which is termed as the Unified Literature Research Process. This process was modelled based on the results from the scientific literature process which was conducted. Therefore, the process is based on both the Traditional Literature Review and the Systematic Literature Review methodologies and derived from the horizontal schemas in Tables 2.5 to 2.12 (outcome of guideline and processes) as well as Table. 2.13 (outcome of models and standards).

4.1 Unified Literature Research Process

The Unified Literature Research Process (ULRP) contains six steps and are described in detail below:

**Step 1 – Preface: Why start searching and check what you already know?**

**Sub step:** Identify the domain of interest  
**Tools:** Any text editor  
**Deliverable:** Domain of Interest

**Sub step:** Prepare a current body of knowledge by writing down what you know about the domain, maybe a few keywords  
**Tools:** Any text editor  
**Deliverable:** Summary of what you already know

**Sub step:** Following from the crux of the Systematic Literature Review Process, a research question or a hypothesis can be formulated but this depends on the experience level of the research and the requirement  
**Tools:** Any text editor  
**Deliverable:** Hypothesis to be proved/disproved or Research question
Step 2 – Pre-searching: What do you need in order to start?

**Sub step:** Identify Initial Keywords using initial knowledge or formulating a research question

**Method:**
1. List the keywords from initial knowledge
2. Use these keywords to locate more keywords from a cataloguing database:
   Library of Congress Subject Headings (LCSH) [R-LSH];
   URL – www.loc.gov/aba/publications/FreeLCSH/freelcsh.html

**Deliverable:** List of keywords to begin with

Alternatively, keywords can be formulated using the research question that is prepared from Step 1. Using synonyms for the different words in the research question, combinations of keywords can be formed.

Step 3 – Searching: Find resources from the generated keywords

**Sub step:** Identify search databases

**Method:** The database can be general or specific to the field of interest

**Tools:** Table 4.1 shows a list of databases to choose

**Deliverable:** A combination of databases to search from

<table>
<thead>
<tr>
<th>Database Name</th>
<th>Link</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google Scholar</td>
<td><a href="http://scholar.google.com/">http://scholar.google.com/</a></td>
<td>Index of scholarly articles</td>
</tr>
<tr>
<td>OALib</td>
<td><a href="http://www.oalib.com">http://www.oalib.com</a></td>
<td>aggregate and index scholarly OA publications</td>
</tr>
<tr>
<td>JURN</td>
<td><a href="http://www.jurn.org/">http://www.jurn.org/</a></td>
<td>search open access journal articles, books and theses (Google custom search over curated index)</td>
</tr>
</tbody>
</table>

Table 4.1: List of databases to choose from for searching [KrB15]

**Sub step:** Searching resources

**Method:** Search using keywords from Step 2 in the databases which are mentioned in the previous sub step. Repeat the process (with more specific keywords or multiple times, if needed) to get focuses results (over-specificity might lead to limited results)

**Deliverable:** Collection of resources. In this step, a lot of resources can be obtained before filtering
Step 4 – Evaluation: Screening resources and evaluating them

**Sub step:** Screening process for data

**Method:** The focus is to read the resource in stages, eliminating resources that do not apply in each stage. The order in which the resource can be read is as follows:

Title → Abstract → Conclusion/Summary → Whole paper

**Tools:** Reading involved in the screening process can be done using the following tools as mentioned in Table 4.2

**Deliverable:** Filtered collection of resources

<table>
<thead>
<tr>
<th>Tool Name</th>
<th>Link</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CrossMark</td>
<td><a href="http://www.crossref.org/crossmark/">http://www.crossref.org/crossmark/</a></td>
<td>show information on the version and updates of a publication</td>
</tr>
<tr>
<td>Utopiadocs</td>
<td><a href="http://utopiadocs.com/">http://utopiadocs.com/</a></td>
<td>PDF reader esp. for scholarly docs suggesting related literature based on what you read</td>
</tr>
<tr>
<td>Readcube</td>
<td><a href="https://www.readcube.com/">https://www.readcube.com/</a></td>
<td>recommendations, PDF-reader, annotator, reference management</td>
</tr>
</tbody>
</table>

Table 4.2: List of applications to choose from for reading [KrB15]

**Sub step:** Evaluation based on criteria

**Method:** Following inclusion/exclusion criteria while reading the resources can be used to further filter the resources:

1. Has the author formulated the problem/issue?
2. Is the scope relevant and critical?
3. Is the targeted readership of paper like you (the reader)?
4. What is the author’s research orientation?
5. Is the resource still relevant in today’s age?
6. Is the author cited before?
7. Is the resource cited before?
8. Are there biases in the study?

**Tools:** The tools as mentioned in Table 4.2 can be used for evaluation to provide tagging and maintaining
Deliverable: Further filtered collection of resources

<table>
<thead>
<tr>
<th>Tool Name</th>
<th>Link</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annotated Books Online</td>
<td><a href="http://www.annotatedbooksonline.com/">http://www.annotatedbooksonline.com/</a></td>
<td>annotation platform for early modern books</td>
</tr>
<tr>
<td>TagTeam</td>
<td><a href="http://tagteam.harvard.edu/">http://tagteam.harvard.edu/</a></td>
<td>open-source tagging platform and open feed aggregator</td>
</tr>
<tr>
<td>PeerLibrary</td>
<td><a href="https://peerlibrary.org">https://peerlibrary.org</a></td>
<td>collaborative annotating; discovery</td>
</tr>
</tbody>
</table>

Table 4.3: List of applications to choose from for evaluation [KrB15]

Sub step: Drawing conclusions
Method: Illustrate certain ideas and revelations that became apparent during the research
Tools: The tools as shown in Table 4.4 can be used for evaluation to create conclusions and representations of the research conducted

<table>
<thead>
<tr>
<th>Tool Name</th>
<th>Link</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sci.ai</td>
<td><a href="http://sci.ai/">http://sci.ai/</a></td>
<td>scholarly writing platform as add-on to Google Docs, creating machine readable papers</td>
</tr>
<tr>
<td>Plot.ly</td>
<td><a href="https://plot.ly">https://plot.ly</a></td>
<td>create graphs (collaboratively)</td>
</tr>
<tr>
<td>Draw.io</td>
<td><a href="https://draw.io">https://draw.io</a></td>
<td>Online flow chart and diagram maker</td>
</tr>
</tbody>
</table>

Table 4.4: List of applications to choose from for conclusion [KrB15]

Step 5 – Reiteration: Adapt search techniques and keywords from current searches

Method: In the research, keep track of keywords and specific ideas that could help further research. Repeat step 3 and 4
Deliverable: Concrete ideas that can add to your current body of knowledge

Step 6 – Keeping current: Maintaining continued interest in the domain.

Method: Setting up alerts and recommendations functionality in the databases
However, this step is important in the long run. However, this step is of minor importance for students who are performing literature research for their seminars or thesis.

### 4.2 Rationale behind picking the tools in the Process

In the 101 Innovation Tools Project\(^{16}\), since more than 400+ tools were available, the makers of the 101 Innovation tools have proposed a model called the “G-E-O model” that helps the researchers to not get affected by the overhaul of tools. According to this model, the tools can be judged on three main factors, i.e.

1. **Good (G)**: the tool does what is expected and the results are reproducible, transparent and fair
2. **Efficient (E)**: Able to be used with other tools, reusable and versioned
3. **Open (O)**: Open access

Based on the evaluation of the above-mentioned tools according to the G-E-O model, the three best tools were chosen and measured on the following three criteria, namely:

1. The tool would meet at least two out of the three requirements from the G-E-O model. If there are no tools that meet two requirements, then the tools that are either open-access or can be connected and used with other tools were chosen.
2. Year of creation, i.e. the tool was published between the years 2000 – 2016, so that it is not outdated as well as trustworthy.
3. It is a general tool or specific to information science (and not related to a geographically specific area or specific to domains other than information science like medical, business, social work etc.)

The information regarding the tools and their values for the above-mentioned criteria is presented in the Table 4.5 [KrB15]:

<table>
<thead>
<tr>
<th>Tool Name</th>
<th>Step that uses the tool</th>
<th>G-E-O criteria</th>
<th>Year of creation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google Scholar</td>
<td>Searching</td>
<td>E-O</td>
<td>2004</td>
</tr>
<tr>
<td>OALib</td>
<td>Searching</td>
<td>E-O</td>
<td>2013</td>
</tr>
<tr>
<td>JURN</td>
<td>Searching</td>
<td>E-O</td>
<td>2009</td>
</tr>
<tr>
<td>CrossMark</td>
<td>Reading/ Screening</td>
<td>G-E</td>
<td>2013</td>
</tr>
</tbody>
</table>

\(^{16}\) https://101innovations.wordpress.com
<table>
<thead>
<tr>
<th>Tool Name</th>
<th>Step that uses the tool</th>
<th>G-E-O criteria</th>
<th>Year of creation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utopiadocs</td>
<td>Reading/Screening</td>
<td>E</td>
<td>2012</td>
</tr>
<tr>
<td>Readcube</td>
<td>Reading/Screening</td>
<td>E</td>
<td>2011</td>
</tr>
<tr>
<td>Annotated Books Online</td>
<td>Evaluation:Filtering</td>
<td>E-O</td>
<td>2012</td>
</tr>
<tr>
<td>TagTeam</td>
<td>Evaluation:Filtering</td>
<td>E-O</td>
<td>2012</td>
</tr>
<tr>
<td>PeerLibrary</td>
<td>Evaluation:Filtering</td>
<td>O</td>
<td>2013</td>
</tr>
<tr>
<td>Plot.ly</td>
<td>Evaluation:Conclusion</td>
<td>E</td>
<td>2012</td>
</tr>
<tr>
<td>Draw.io</td>
<td>Evaluation:Conclusion</td>
<td>E-O</td>
<td>2005</td>
</tr>
</tbody>
</table>

Table 4.5: Criteria used for selecting the tools in ULRP
Chapter 5

Implementation of the Extendable Process Guide

To complement the research, it was necessary to have a tool that would help in propagating and extending the unified process in the university-setup and provide a platform to extend the process based on the situation and the target group. This chapter deals with the implementation of the tool.

5.1 Technologies used for Implementation

The technology used for the implementation is the MEAN stack. MEAN is an acronym where M stands for MongoDB\(^{17}\), E stands for Express.js\(^{18}\), A stands for Angular.js\(^{19}\) (Angular 2 has been used in the implementation) and N stands for Node.js\(^{20}\).

These component technologies although developed at separate times are now used as a unit because JavaScript binds them together and provides both client-side as well as server-side functionalities. These are the reasons for picking MEAN Stack for development:

1. The three components in MEAN are all-in-all JavaScript. Thus, it provides both client and server-side scripting. Also, JavaScript being enabled by default on all modern browsers is an advantage. JavaScript is one of the most powerful and popular languages in the developer community and MEAN stack is one of the rapidly developing JavaScript derived technology. Thus, getting help on developmental problems in the communities and forums will be easy.

2. MEAN stack is open source and free. Several libraries are written to be used for different cross-platform and varied functionalities inside the MEAN projects.

3. MongoDB is a NO SQL (non-relational as opposed to SQL), document model database. Since, the tool is built for the university-setup with a third-party API, it might have to deal with tons of student data which is susceptible to change in structure. MongoDB can adapt easily to addition of data to its document modelled collections. MongoDB and the Node.js frameworks complement each other because they are both JavaScript frameworks. Additionally, they can pass around JSON data by default without any required conversions.

4. The L2P API also returns data as JSON by default and ease of use of JSON along with the whole MEAN Stack is an advantage for the implementation.

\(^{17}\) https://www.mongodb.com/
\(^{18}\) https://expressjs.com/
\(^{19}\) https://angularjs.org/
\(^{20}\) https://nodejs.org/en/
5.2 View and Progression of the Process

The view of the Process and the Steps must be sequential and apparent so that respondent of the Process understands the progression and is able to follow the Process with ease. Thus, the Process needs to have a natural progression with a sequential view. A progress bar is the natural way to go as it would show the current state in Process as well as show how much of the Process is still remaining. As mentioned in the previous subsection, MEAN Stack allows inclusion of different libraries in the project. A library that would depict the succession of a Process and its Steps was required. The "twitter-bootstrap-wizard" library\(^{21}\) allowed the creation of a wizard functionality that would let the user go through the Process with the help of navigation buttons. There are many styles of progress bars to choose from, where each style is a combination of controls that would help progression through a given Process. Figure 5.1 shows a possible control combination that twitter-bootstrap-wizard has to offer. In the example shown (Figure 5.1), there are seven steps in succession and the progress bar increases in size with every step. Similarly, the same analogy is used to provide the visual understanding when a process is undertaken.

![Figure 5.1: Example Twitter Bootstrap Wizard to show succession of steps](image)

5.3 Implementation Modules in the Process Guide

This section contains the implemented features in the Process Guide Tool. This section is mainly divided into three parts based on the roles of the users, namely:

1. Functionality common to both managers and students: Landing page, Login

\(^{21}\) https://cdnjs.com/libraries/twitter-bootstrap-wizard
and Dashboard view

2. Functionality offered to only managers: Process Creation

3. Functionality offered to only students: Responding to Processes

5.3.1 Functionalities Common to Both Managers and Students

When the user first opens the application tool, the home page is shown in Figure 5.2. The page shows a welcome note and some instructions to begin with in the form of a workflow. This is so that the user knows the main function of the application after login and this could increase the efficiency of a first-time user.

![Landing page](image)

**Figure 5.2:** Landing page of the application with a sample workflow with initial instructions

The targeted audience for the process guide tool is the teaching staff and students of RWTH University. As discussed before, RWTH L2P API and the RWTH L2P Authentication API are used to develop the tool in the context of the university. On Login,
the OAuth Authentication\(^{22}\) happens through the L2P authentication API. The user has to authorise the application and then the validated user will be redirected their own dashboard.

The methods that are used from the RWTH - L2P2013 API are

1. “viewAllCourseInfo”\(^{23}\)
   After identifying the user, this method provides a list of all courses that the user has been enrolled in or associated with as a provider.

2. “viewUserRole”\(^{24}\)
   For each of the course, this method will provide a role for the user. As mentioned before in the Conceptual Approach, there are three roles that are provided by the L2P API, but based on the relation with the possible functionalities, there are two main grouping.

   1. Student/ Extra: In the context of the tool, a student/extra respondent to the Process
   2. Manager: In the context of the tool, a manager is the creator/editor of the Process

After the login and authentication, the user is navigated to the Dashboard. With the help of the L2P API functions, all the courses of the user in all previous and current semesters are shown in the Dashboard view. The courses are listed alphabetically. The Dashboard view also provides a search bar that will search courses by name and semester. Figure 5.3 shows the Dashboard view with the courses and the search bars.

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\(^{22}\) https://oauth.net
\(^{23}\) https://www3.elearning.rwth-aachen.de/_vti_bin/L2PServices/api.svc/v1/Documentation#H2-viewallcourseinfo
\(^{24}\) https://www3.elearning.rwth-aachen.de/_vti_bin/L2PServices/api.svc/v1/Documentation#H2-viewuserrole
Each course displayed contains two different sections. One is the course information and the second is the workflow information. The course information is shown in Figure 5.4. The course information is shown so that the user has initial information about the course, without having to check in L2P course room in the L2P website. For additional information about the course, the user can use the course link to go to the L2P course room.

In the process section, if there are no workflows already added in them, then the state of the view for the student is shown in Figure 5.5.
Figure 5.4: Course information in the dashboard

Figure 5.5: Process section for the student when there are Processes yet
For a manager, when there are no Processes inside a course, then the manager is allowed to add a new process. The view for the manager is shown in Figure 5.6.

![Process section for the manager when there are Processes yet](image)

**Figure 5.6:** Process section for the manager when there are Processes yet

If there are Processes inside the course contexts, they can be viewed by both the students as well as the managers. The view functionality of the dashboard allows to view the Process that is created in the course contexts. The view page looks as in Figure 5.7.
5.3.2 Functionalities Offered to the Manager

The manager is allowed to create Processes in any of the courses managed by them. When the manager creates a new Process under any course, then the Process will be added in that course’s context. It can be done in two ways, i.e.

1. Create Processes from scratch

2. Create Processes from templates

When creating a Process from scratch, the manager first adds the Process description and then adds the Steps within the Process. The Create Process view is shown in Figure 5.8. Both the Process and the Step have title and body. Hence the Add Step view is like the Create Process View. The manager is thus, allowed to view, create, edit and delete a Process and the Steps within them. The courses can have multiple managers. Any manager of the same course will also be able to perform all the above-mentioned actions on the Process that were created in the course contexts of their managed courses. The application also allows the change of the Step order. The application allows the manager to assign sequence numbers only between 1 and N (where N in the total number of Steps in the Process) in each Step.
The Templates section of the application can be navigated through the New Process View. The Templates section offers the Processes previously created by the user and which are created by an admin user (which is predefined in the implementation). All managers will have access to the templates already offered in the application. The Unified Literature Research Process (ULRP) is the template that is offered. In addition, the managers will also see the Processes created by them in the past. The Templates section is shown in Figure 5.9. By editing and using any of the Templates, the process and its member Steps will be created in the context of the course from which it was navigated. In Figure 5.9, e.g. the ULRP template is shown that can be edited and used in a course.
Figure 5.8: New Process from Scratch by manager
Figure 5.9: Templates section for manager: to create Process from Templates
The delete functionality will delete the *Process* from the course context as well from the Templates section if it was previously created by that user. The delete view of the application for the manager is shown in Figure 5.10.

![Delete Process](image)

Figure 5.10: Delete functionality for the manager
5.3.3 Functionalities Offered to the Student

The students are offered the functionality to undertake Processes. A Process can be started from the Dashboard. When the user logs out and later logs in, the Process continues with the previously made changes. The previously made changes refer to the started Processes under different courses and the progress in those Processes. When a student first encounters a Process in the course context before starting the Process, the Dashboard view of that Process which the user encounters is shown in the Figure 5.11. When the student has already started a Process, the dashboard view of the Process changes as in Figure 5.12 where the “Start Process” button is now “Continue Process”.

Figure 5.11: Process as seen by the student before starting it
Figure 5.12: *Process* as seen by the student after starting it

The landing page for starting or continuing the process is always the first *Step*. Figure 5.13 shows a recently started *Process*.
While undertaking a Process, the user can go through each Step and finish performing the instructions in that Step. The completion of the Step is left to the discretion of the user. The design of the Process is simple so that the Steps can be revisited as often as required by the user. To mark the finishing of each Step, the user can click the “Finish Step” button. In the Figure 5.13, the “Finish Step” button for the first Step: Preface is seen. So, for example, if the user decides the completion of the Preface Step, then the user clicks the “Finish Step” button. Figure 5.14 shows the status of the Step after the user has clicked “Finish Step” button. Note that the progress bar has naturally progressed. The progression is a simple mathematical percentage-calculation which the application calculates based on the number of Steps in the Process and the number of finished Steps. So, for a total of 6 steps, the progress bar must show 1 out of 6 as complete or in other words 16.67%. Hovering on the progress bar shows the percentage finished as shown in Figure 5.15. The main idea is that the user can keep track of the progression in the Process. Figure 5.16 shows further progression in Step 3. In this case, the progress bar shows 50% when hovered upon because exactly half of the Process has finished. The twitter-bootstrap-wizard library does not allow the functionality to show the percentage of the progress and had to be added.
Step 1: Preface: Why start searching and check what you already know?
Tools to use: Any Text Editor
1. Identify the domain of interest
Deliverable: Domain of interest

2. Prepare a current body of knowledge by writing down what you know about the domain, maybe a few keywords
Deliverable: Summary of what you already know

3. Following from the crux of the Systematic Literature Review Process, a research question or a hypothesis can be formulated but this depends on the experience level of the research and the requirement.
Deliverable: Hypothesis to be proved/disproved or Research question
In the Process Guide, there are two different types of progress bars. The first progress bar correlates to the completion of *Steps*. Thus, only when the *Step* is considered finished, then the progress bar progresses in percentage using the formula i.e. $((\text{number of finished } \text{Steps}) / \text{total number of } \text{Steps}) \times 100)$. The second progress bar shows where the user is currently at in the *Process*. Note that this progress bar is independent of completion of the *Step* but simply provides a mathematical sense of the number of *Steps* available. Each time, the user clicks on a *Step*, this progress bar progresses by the same formula i.e. $((\text{current number} / \text{total number of } \text{Steps}) \times 100)$. Figure 5.17 depicts both the progress bars with labels “first progress bar” and “second progress bar” respectively.

**Figure 5.17: Two types of progress bars**

**5.4 Database Design for the Process Guide**

There are six collections or non-relational models in the database design for the tool. Figure 5.18 shows the relations between the different models. An inward arrow means that the adjoining field is in the model that receives the arrow. A double-sided arrow means that there is a two-way relation. A double arrow means that an array of a particular model is used in the model receiving the arrow.

1. **Usersso Model**
   This model saves the token information passed by the RWTH L2P Authentication API to identify the user in the context of the application and also keep the session alive and revive it upon next login.

2. **Workflow or the Process Model**
   This model consists the Template information as well as any *Process* that is created in course contexts. This model is related to the Usersso model by one simulated foreign key to join the two. In Figure 5.18, the inward arrow from Usersso relates the two.
3. Course Model
   This model stores and updates the course information from RWTH L2P API. Not all the course information is saved, since this is information from external source and is susceptible to change. The role information for the user with every course is saved here. The Course model is also related to the Usersso model, where each course is saved or updated for a user’s session. Also, the Workflow model is related to the Course model. The relation ensures that only one workflow is created inside one course. Course Model is related to Workflow in a two-way relation, hence a workflow exists for a course and a workflow can have a course related to it. Note that the templates are also workflows and can exist without being related to a course.

4. Course_Workflow Model
   This model is the adjoining model for Course and Workflow models. This ensures that every user that is registered under a course can see the workflow inside that course. This model is updated each time, the workflow is deleted, or a different workflow is added instead of an older one. It is the adjoining model for both course and workflow include members from both models.

5. Step Model
   This model consists of all the steps created for the different workflows. Thus, each step is related to one or the other workflow in the Workflow model. The inward arrow in Figure 5.18 denotes that the Step model includes the member key from Workflow model.

6. Subscribe Model
   This model consists of all the workflows that have been started by the “Students” or “Extras”. This model saves the progress of each of the students for the respective workflows by saving a set of finished steps (in other words, an array of the Step model) as well as the percentage completed. This model is updated each time a step is finished. As shown in figure 5.18, Step array sends multiple arrows to Subscribe model to show an included array of steps. It is related to Usersso model shown by another inward arrow.
Figure 5.18: Database design of the Process Tool Guide
Chapter 6

Evaluation of the Extendable Process Guide

For evaluating the Process Guide, User Evaluation Process and User Functional Testing have been conducted. The entire process involved five participants from Bachelor and Master Courses of varied backgrounds. The evaluation process first involved the user experience evaluation with Cognitive Walkthrough and then followed by the surveying methodology [Spe00]. For this purpose, one survey that uses Nielsen's Attributes of Usability has been used [Nie93]. It is used to check the ease of use of the system and analyze the tool on five different criteria called the Nielsen’s Attributes, i.e. Learnability, Efficiency, Memorability, Errors and Subjective Satisfaction. The results of the functional testing, the cognitive walkthrough and the survey were recorded and presented in this chapter.

6.1 Methodology of Evaluation

The users were asked to perform seven tasks and think aloud while doing so. The tasks were:

1. Logging in with their SSO Log in
2. Navigating to Dashboard and viewing one’s own courses
3. Viewing Course Information
4. Adding a Process from Scratch as a manager (Test course)
5. Using a Template to add a Process (Test course)
6. Undertaking a Process (Simulated Process)
   1. Finishing a step
   2. Undo Finish
7. Using the progress bars or perceiving their significance

The results were recorded according to the tasks for each user and measured in two criteria, namely:

1. How did the user perform?
   This was recorded as the result of cognitive walkthrough
2. How did the system perform?
   This was recorded as the result of the User Functional Testing
Then, the users were asked to fill out a survey to test the ease of use of the system with five criteria called the Nielsen’s attributes. The survey questions are shown in Figure 6.1.

![Figure 6.1: Survey to measure the Nielsen’s Attributes](image)

In Figure 6.1, ease of use measures the level of difficulty in understanding the system while using it. The four criteria used to measure these are as follows:

1. Learnability: How easy it is to accomplish tasks on first try?
2. Efficiency: How easy it is to accomplish tasks once mastered?
3. Memorability: How easy it is to regain expertise in using system after a significant gap?
4. Errors: How many errors does user makes while using the system?
5. Satisfaction: How pleasant is the design?

The five users who took part in the evaluation process were bachelors and masters students. For the cognitive walkthrough, one bachelors student and one master student (User 1, 2) were randomly chosen to be the testers with no prior knowledge of the system and the remaining three were briefed about what the system does (User 3,4,5). However, all five students were made to test without any prior user experience of using the system. All the survey’s results were conveyed anonymously.

### 6.2 Results of the Evaluation Process

The results of the cognitive walkthrough are shown in Table 6.1. A metric has been prepared to evaluate the cognitive walkthrough. When the users performed the tasks, an assessment was made to measure the ease with which they navigated and finished the tasks. The users were awarded points from 1 to 5 where 1 stands for great difficulty in performing the task and 5 refers to great ease.
### Function

<table>
<thead>
<tr>
<th>Function</th>
<th>User 1 (No prior explanation given)</th>
<th>User 2 (No prior explanation given)</th>
<th>User 3 (Prior explanation given)</th>
<th>User 4 (Prior explanation given)</th>
<th>User 5 (Prior explanation given)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logging in with their SSO Log in</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Navigating to Dashboard and viewing one’s own courses</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Viewing Course Information</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Adding a Process from Scratch as a manager</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Using a Template to add a Process</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Undertaking a Process</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Finish step</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Undo finish</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Perceiving the significance of the progress bars</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>28</td>
<td>29</td>
<td>36</td>
<td>40</td>
<td>35</td>
</tr>
</tbody>
</table>

Table 6.1: Results of the cognitive walkthrough
The user functional testing results were also recorded. The system was under scrutiny for each task when the users performed them. The results of the user functional testing are shown in Table 6.2. The users were performing the task and a task was considered “Pass” if there were no bugs while performing that task, otherwise it would be considered “Fail”. As shown in Table 6.2, there were two bugs which resulted in fixes.

<table>
<thead>
<tr>
<th>Function</th>
<th>User 1</th>
<th>User 2</th>
<th>User 3</th>
<th>User 4</th>
<th>User 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logging in with their SSO Log in</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Navigating to Dashboard and viewing one’s own courses</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Viewing Course Information</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Adding a Process from Scratch as a manager</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Using a Template to add a Process</td>
<td>Fail</td>
<td>Fail</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Undertaking a Process</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Finish step</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Undo finish</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Using the progress bars</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
</tr>
</tbody>
</table>

Table 6.2: Results of the user functional testing

The results of the ease of use survey is shown in Table 6.3. The ease of use is measured on the five criteria. A value 1 means that the system tested badly on that criteria and a value of 7 means that it tested well on that criteria.
# 6.3 Discussion

The results of the cognitive walkthrough in Table 6.1 shows that overall all the users were able to finish the tasks assigned. It is seen that there is a significant difference between the performance of the users who were given a prior briefing in using the system and the ones who weren’t. A perfect score of 45 is the benchmark, then the least performing, non-informed performer received a score of 28, i.e. 62.2% and the least performing informed performer received a score of 35, i.e. 77.77%. Thus, it is seen that a brief description of the system before using it increases the efficiency by 25%. It was further observed that the tasks of creating the workflows from scratch and from templates were the most difficult one to perform. The users required some amount of guidance to perform. The student module tasks were simpler to perform and were performed similarly across all users. Thus, the manager module requires some amount of expertise in the system to perform the tasks.

The results of the user functional testing as shown in Table 6.2 measure as per a benchmark where all the tests passing would result in 100% success rate i.e. all the 45 tasks were passed. But, the system was successful 95.5% of the time, i.e. 2 out of 45 test cases failed and 43 out of 45 passed. This answers the second question of the evaluation process.

The results of the user survey to measure the ease of use is shown in Table 6.3. The benchmark perfect score for each criterion would be 35, as a collective score by all users for one criteria. As also seen in the results of cognitive walkthrough, the learnability of the system is low i.e. for first time users where it has scored 15. However, due to the simplicity of the expectations that the system has from the user, the efficiency of the user

## Discussion of cognitive walkthrough

<table>
<thead>
<tr>
<th>Function</th>
<th>User 1</th>
<th>User 2</th>
<th>User 3</th>
<th>User 4</th>
<th>User 5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learnability</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>Efficiency</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>Memorability</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>32</td>
</tr>
<tr>
<td>Accuracy</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>Subjective Satisfaction</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td>25</td>
</tr>
</tbody>
</table>

Table 6.3: Results of the survey measuring the system with Nielsen’s attributes
is significantly higher than learnability which is 30. Also due to the simplicity of the tasks, the memorability is also seen to be on the higher side which is 32. As seen in Table 6.1 in the results of the cognitive walkthrough, accuracy was lower in the case of users who were not briefed in the beginning were individual scores of each user in that criterion is lower in the case of User 1 and User 2. Finally, because of simple expectations in performing the tasks, the subjective satisfaction of the whole design is well above the mean with a score of 25. Overall, we can conclude that the ease of use increases significantly with experience on using the system.
Chapter 7

Conclusion and Future Work

This thesis aimed at solving the problems of inexperienced researchers when performing literature research. An experienced researcher will have tried, tested and perfected his/her own research process over the years but an inexperienced researcher is overwhelmed by all the different possible steps involved in the process. Thus, a unified process that would allow an inexperienced researcher to perform literature research with ease is developed in this thesis. Students in a university-setting can be considered as inexperienced researchers who are performing literature research in order to increase their body of knowledge, to write a seminar paper or thesis.

To define a unified process, I conducted research in four directions, i.e.

1. Existing Literature Research methodologies of Literature Research
2. Models and Standards of “Information Literacy” proposed by different countries
3. Individual and Institutional Guidelines for performing Literature Research
4. Guidelines for performing Literature Research published in scientific and academic capacities

Reviewing the state-of-the-art of the existing literature methodologies showed that Traditional Literature Research and Systematic Literature Research processes are the commonly used ones. The methodologies have clearly defined steps that could be then utilized in creating a unified process. Different institutional, individual and scientific guidelines that aim at partially defining a literature review have been researched. The guidelines are presented as tips for conducting reviews and can be translated into a process. To map these guidelines from the second and third directions of research mentioned above, a horizontal schema was created and used. A horizontal schema is created by grouping the commonalities in the different guidelines vertically and then imagining as if all the vertical groups were placed side by side to form a process. By applying this, a horizontal schema with eight groups were created, i.e.

Group 1: Why conduct research and what you already know?
Group 2: Pre-How? Organizational tasks and initial formulation before you begin
Group 3: Where? Where to look? As in databases and resource collections
Group 4: How? How to Continue? – with keywords
Group 5: What to do with the data? Evaluation
Group 6: Reiterating: Repeating groups 4 and 5
Group 7: Writing a literature review
Group 8: Keeping current with research topic

From the fourth direction of research, different models and standards of Information Literacy were researched and created a similar horizontal schema with seven main steps, namely:

- **Step 1: Identify**: identifying the need and extent of information needed
- **Step 2: Scope and Access**: finding where to search and to what to search
- **Step 3: Application**: Initial preparation before searching
- **Step 4: Gather**: Locating resources using search techniques and parameters
- **Step 5: Evaluate**: Use criteria to evaluate the gathered resources
- **Step 6: Manage**: The socioeconomic and legal repercussions of using resources
- **Step 7: Present**: Sharing acquired data with community

Using the four directions of research and the schemas that were created a unified process called the Unified Literature Research Process (ULRP) was generated. The structure of ULRP was that there are *Steps* inside the *Process*. The Steps are further divided into *Substeps* and to perform the *Substeps*, some *Methods* and *Tools* are provided. Finally, at the end of a *Step*, when all *Substeps* are finished, a *Deliverable* is expected. ULRP has six steps, i.e.

- **Step 1: Preface**: Why start searching and check what you already know?
- **Step 2: Pre-search**: What do you need in order to start?
- **Step 3: Searching**: Where to search and what to search with?
- **Step 4: Evaluation**: What is relevant to the research out of the gathered information?
- **Step 5: Re-iterating**: Repeat steps 3 and 4 for more focused results
- **Step 6: Keeping Current**: keeping up to date with the changes in the field of interest

ULRP is designed for inexperienced researcher and thus needed to be propagated in a university-setting. Thus, a process guide tool was created for this purpose. The tool is a web application which follows two main roles, i.e. Student and Manager. In the context, a Manager creates a *Process* in the tool under any course that they are managing, and the Student can undertake that *Process* and keep track of their own *Process*. To guarantee the extendability of the process guide tool, the Managers are even permitted to modify the ULRP, which is offered as a template or create their own *Process* under their managed courses.
The Process Guide tool was evaluated with the help of five users using Cognitive Walkthrough, User Functional Testing, and a survey to measure the ease of use. Overall, the system was proved to be challenging to use for first-time users but the simplicity of the tasks to be performed in the system shows promising efficiency, memorability right from the second attempt. The overall design satisfaction is also well above average and the tool is robust in 95% of the attempt before bug fixing. The student module had high learnability which means that it is easy for a first-time user to use the system and perform all the student tasks, but it was observed that the manager module required some amount of expertise to perform all the tasks.

The Unified Literature Research Process (ULRP) is based on the different guidelines, processes and standards that we have so far witnessed and also Traditional and Systematic Literature Review methodologies. Evolving the process so that it is a hybrid of other forms of Literature reviews can be an area of interest in the future. Thus, we can guarantee that the best aspects of all the forms of Literature reviews are included in the process. For example, a narrative literature review is focused on the writing aspect. The unified research process has not covered the writing aspect. If a written report is expected at the end of the research, then such a step can be helpful to the researcher. In addition, the process does not use any learning or data metaphors in the searching step. Some of the key metaphors of search include “funnel (funnelling in)”, “concertina (narrowing and enlarging your search, like a concertina windbag)”, and “lens (to focus readers)”. Such metaphors could provide the user with an idea of how the encountered data transforms as the process progresses. Figure 7.1 shows the metaphors of learning [LeE06]. Thus, in the searching step, an extensive section using the metaphors and a quantitative idea of how many results are appropriate can be added. To strike a balance with the amount of results based on the topic and how many results are appropriate needs some future analysis.

![The “funnel”](image1)

![The “concertina”](image2)

![The “lens”](image3)

Figure 7.1: Key metaphors of literature search process [LeE06]

For the process tool guide, there are some improvements that can be made as future prospects. Even though the tool has been built according to the specifics for RWTH Aachen University, it has not been tested for a seminar or a course that is actually a part of the curriculum. The testing model can be as follows: the managers of the seminars or courses can add steps in the courses every week so that the students can undertake them in order to perform their literature research. In addition, the Process that is the atomic unit
of the tool has members namely Steps and Substeps and Substeps have Methods, Tools and Deliverables. However, in the application, only the Process and Steps are database models and the rest of the elements are simulated as text. As a future improvement, these sub modules could be translated into actual database models and the process could allow individual creation possibility.

From the research conducted, it was apparent that the different processes, guidelines, standards and models could be grouped in a way to create a unified process. Due to the varied nature of research required across domains, differences in the process are expected and can be guaranteed with extendability. But, all the research institutions, individuals and the government initiatives for learning coming together for creating and following one unified process similar to ULRP still has immense scope of research.
Chapter A

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Baliga Bantwal, Neetha

Name, Vorname

Matrikelnummer (freiwillige Angabe)

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An Extendable Process Guide for Scientific Literature Research

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