LETTERS TO THE EDITOR

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Interdisciplinary Integrated Tools to Problem Solving: How to Apply to Writing a Thesis and Planning a Research

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Dear Editor,

Writing a thesis or a research proposal poses enormous challenges specially in these times of information superabundance. And the positive side is that we have a lot of information to use during our research.

The other phenomenon to take into consideration is the misinformation and how it could affect our research. Again, we can overcome this difficulty by applying structured research methods.

The methodology proposed here starts with understanding the research problem applying the systemic thinking; then looing for information with mapping studies; evaluating the publications obtained with information quality tools; testing multiple hypothesis at the same time; and finally, if needed preparing a Gantt chart to plan the research.

All these methodologies when together highlight the positive side of the synergies while minimize the impact of the cognitive bias.

The aim of the study. To describe the importance of having a structured tool to write a thesis or setting up a research project.

The proposal presented here is a problem-solving course that includes five methodologies: systems theory, mapping studies, information quality, and competing hypothesis, plus the Gantt chart. When they are used in sequence, it is possible to obtain outstanding results and also the process is auditable in its whole extension.

This course has been presented several times at universities and other places in Argentina and also in Peru, with interesting and relevant results.

We consider that the first situation to address is how we see the world, and its problems. To do it, we present a lecture on mental models and discuss the different perspectives we all have when approaching any given subject. The students enjoy a lot this lecture since it allows them to see how different we all are but see this as something positive that helps to build and understand the world, not destroy it.

Then, they are ready to focus on their specific problems and start to understand and work on them.

The second lecture is on the systemic thinking, this method helps them to conceptualize the research problem.

In summary, the key assumptions of this theory developed by Von Bertalanffy (1968) are:
1. Systems exist within systems.
2. The systems are open.
3. The functions of a system depend on its structure.

According to Von Bertalanffy (1968), the system functioning includes inputs and outputs, processes and the components involved. In some cases, the output becomes the input of the system (feedback).

This first step is the one that takes longer since understanding the problem is the most difficult phase. The identification of the process and its components is critical to the next steps of this sequence.

At this point, the students decide with which problem or situation they want to analyse and understand. By doing this, they move out from the words of the ideas to drafting them. This process takes time and requires reflection, and also decisions should be made to set up the limits (system border) and the components – and relations between them – of the problem under study. When doing this conceptualization process, the system is developed with a specific objective and if the objective changes, the system will also do.

Once the system is ready, the third step is to look for information in a structured way. In this methodological sequence, the mapping studies technique will be applied. With the information obtained here it is possible to prepare the State of the art of any thesis or research proposal.

There are many ways to do it, here we will do a systematic literature review (or systematic mapping studies) designed by Kitchencham et al. (2010) from Keele University. Also, Genero et al. (2015) from the Alarcos Group (University of Castilla La Mancha – UCLM – Spain) are leading the field in Spanish-speaking countries.

The outstanding feature of this tools is that to select the different articles when searching in any searching engine, the selection is made if the article answers or not to a research question, it doesn't matter how it does but if. In this way, we are sure that all the possible options are registered.

The methodology includes three phases: planning the review, executing it and writing the report.

In the first phase, many tasks will take place. First, the need for a review must be identified. It is important to note that by doing this review, it is possible to summarize all the information on a topic, in a format that resembles a database.

To begin with the practical steps of this tool, the research questions formulation is the next step. These research questions will be the tool to select the publications, considering whether they answer or not to them, and not how they do (this is important for the later analysis of the results). This way of selecting the publications helps to minimize the impact of our cognitive bias, allowing us to have the whole set of possible answers, and not only the ones we like.

Before performing the search, a protocol must be developed. This plan includes: the identification of the search terms (plus synonyms and other alternative terms, and the use OR and AND, or other Boolean operators is recommended); the sources of information must be chosen and specified (use virtual libraries, Google or other search engines); inclusion and exclusion criteria; and the design of a form to transfer the selected publications and the research questions, usually an Excel sheet.

In the second phase, the review takes place, and all is executed according to the plan. Now, it is important to check all the results, one by one, and the publications that answer the research questions will be transferred to the Excel file and the different fields will be completed. The inclusion and exclusion criteria will help to filter the

results obtained, and finally the result will be a set of publications that fulfil the requirements and answer the research questions.

Once we finish downloading and answering the questions, it is time to analyse the results: comparative analysis and graphs are easy to make and to show the state of the art of any given topic. Studies that using the traditional methods could take ages, using this tool is possible to be done in just minutes.

The fourth step is applying the information and data quality tools; since the information obtained could be validated using the information quality techniques, and in this way, it is possible to evaluate its properties (Espona & Fisher, 2015). In this sense, experts at the Massachusetts Institute of Technology (MIT) (Cambridge, Massachusetts, USA) developed an information quality method. Lately, professionals from other universities and countries expanded and added more elements to it.

Wang and Strong (1996) developed a framework to evaluate and hierarchically organize information. To create this method, they sent a survey to information consumers and master's in business administration (MBA) students asking about the most critical attributes that information should have. The result was a list of 179 attributes. After that, they performed a second survey to learn and understand the importance of the attributes identified. Finally, they come out with a list of 15 dimensions, grouped into four categories:
- Intrinsic (accuracy, believability, objectivity, and reputation);
- Contextual (value-added, relevancy, timeliness, completeness, and amount of data);
- Representational (interpretability, ease of understanding, representational consistency and representation conciseness);
- Accessibility (access and security).

It is important to point out that these dimensions could be evaluated both quantitatively and qualitatively. And that the clear definition of all of them contribute to the evaluation, understanding and communication in the field of knowledge and in the organization in which the research is taking place.

The fifth step is competing hypothesis. This tool was developed by Heuer (1999), an intelligence analysis expert from the Central Intelligence Agency (CIA), during the Cold War, and a few years later was provided to the public.

This tool is especially useful in cases of complex problems, with many possible scenarios and a lot of evidence to analyse. It allows to study simultaneously all likely hypothesis and verify them with all the available information simultaneously. In the case of a thesis maybe is not always useful, but yes in the case of a research where more hypotheses are on the table.

Also, all the evidence already gathered in the mapping studies could be considered the evidences in this method, saving a lot of time and creating a positive synergy. The outcome will be a table including the evidence and the hypotheses and the results of the evaluation performed (Table 1).

Table 1

Resulting Table as Consequence of the Execution of the Competing Hypothesis Method

Evidences	Hypothesis 1	Hypothesis 2
Evidence A	Support (+)	Support (+)
Evidence B	Highly support (++)	Not support strongly (--)
Evidence C	Support (+)	Not apply (no relation)
Evidence D	Not apply (no relation)	Not support (-)
Evidence E	Not support (-)	Support (+)
Subtotal	4 (++++); 1 (-)	2 (++); 3 (---)
Total	+3 (+++)	-1 (-)

The winning hypothesis, in the Table 1 example will be the Hypotheses 1. But it is important to remember that the winning hypothesis has more support according to with the available evidence and not a higher probability of occurrence.

In the case this method is performed, and a winning hypothesis is identified, it means the solution to the problem with more support in the available information has been found.

Finally, it is time to plan the implementation using the Gantt chart. To do it, first the objectives and tasks must be identified. There are four phases: design, planning, execution and evaluation. The objectives preferable must be SMART (Doran, 1981).

In this last step, must be taken into consideration the system designed at the beginning and put it together with the winning hypothesis. This is part of the diagnosis, that needs also a survey to include the qualitative evaluation of the situation. Planning and Executing follows the usual logic but during the evaluation is good to add a new survey to include again the people involved and get their opinion, always critical to the success.

This problem-solving course has been presented in different formats many times, to different audiences, with different objectives, with outstanding results.

Considering the audience and their specific needs, the focus is on the different methodologies. Usually, the most demanding stage is the implementation of the systemic method but at the same time it is the most rewarding, since many participants experience Eureka moments when discovering their real problems.

The methodologies included in the courseled to finding the solution to many problems, in an unbiased, structured, auditable and at the same time, in a simple way.

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