A Research Publishing Checklist for New Authors

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Abstract

While traditionally information systems (IS) students graduated then published, today they often publish before they graduate. While publishing seems yet another student burden, it can be a useful learning experience, raise motivation, provide helpful feedback, help grant and job applications, and give student and advisor a common focus. That research publishing is an extra demand suggests the need for a support tool. The research publishing checklist: 1. Chunks knowledge into elements for easier handling. 2. Grounds elements with practical examples and summary statements, and 3. Structures the elements in academic format for easy location. It can be used not only in student advising, but for new authors in any context, whether conference, journal or book chapter. The checklist is available at http://brianwhitworth.com/researchchecklist.pdf

Keywords

Thesis, PhD publishing, postgraduate education

Introduction

Background

While traditionally information systems (IS) students graduated then published, today many publish before they graduate (Larsen, 1998). Putting students on the publication treadmill is stressful, but perhaps it also lets new researchers "cut their teeth", as it were. Benefits include student recognition, better motivation, making useful connections, justifying grant support, and a common advisor/student focus. Third party reviews expose students to comments independent of their advisor. Assisting students to publish has become an important advisor duty, as students without this may be disadvantaged when applying for a job. While publishing seems yet another burden, it also contributes to the higher learning experience.

Goal

If student publishing is common it needs to be a planned forethought not an afterthought. This new demand on students and advisors (to publish) suggests the need for a tool to support it, such as the following checklist which aims to support student/advisor interaction. While doing the research itself is a major effort, writing it up also deserves a focus. Some publish frequently because they submit frequently, as research that is not written up never gets published (Van Slyke et al, 2003). This paper is not about the political, financial and motivational issues of getting a PhD (Grover, 2001), or how to write a thesis (Phillips & Pugh, 1994), nor about how to maximize publishing rates (e.g. choosing "least publishable units"). The focus here is on publication excellence.

Approach

In the following, note that research is:

1. ***Complex.*** Research is a way of approaching knowledge that humanity has developed over hundreds of years. It has many aspects, and there is no single "right" way. No "formula" or cookie cutter template can define it, as each research instance is a complex balance or "golden mean" of many things.

2. ***Abstract.*** Knowledge about research is often stated abstractly, where one abstract principle can have innumerable concrete examples. To interpret these abstractions in a specific case usually requires an advisor, someone who has gone through the process themselves.

3. ***Dynamic/Holistic.*** Research is not just the mechanical gathering of data to fill up a fixed picture of knowledge. If it were this simple it would be done already, which it is not. Research creates not a body of "facts" but whole new understandings. It is a dynamic *process* not a fixed *product.* Its premise is that *we don't know but by asking the right questions in the right way can gain more understanding*.

Research complexity suggested "chunking" research knowledge into elements that students can select and digest. Research abstractness suggested supporting the advisor-student interaction with summary statements and examples. Research dynamism/holism suggested organizing elements to mirror the academic form, to allow for easy location. *Since the research journey is complex, with abstract signposts, on a dynamic terrain, students need experienced advisors to guide, interpret, and warn.* This checklist aims to support that process.

Constraints

Note that:

a. *This is a research checklist not a research method summary*. To summarize research methods would need a book (e.g. Rosenthal & Rosnow, 1991). The goal here is to “tag” the knowledge element, not fully specify it, so advisors can expand or correct points, or make them signposts into a larger text.

b. *Element relevance varies between topics and methods.* Different disciplines prioritize elements differently, e.g. qualitative studies don’t need statistical analysis. In this “toolbox” approach, that not all tools (elements) are used in every case is normal.

c. *Order and terminology varies between topics and methods,* e.g. element order within sections often varies, and different disciplines use different names for similar concepts.

The checklist

Elements specific to a particular field or method are marked with an asterisk (*).

Overview

1. ***Collegiality***. Research is a social activity as well as an intellectual one, done by a community whose *culture* is the research method. This culture combines logic and physical world information, as theory and practice work better together than apart. Logic is an excellent tool, but like a sword can “cut” its user and is dangerous to use alone. Feedback from the world protects against theory imagination, but like a forest its detail can overwhelm, and one can easily get lost. In this analogy, research uses the sword of logical argument to cut through the forest of physical data to find new paths of understanding. In this culture, members resolve disagreements not by conflict, but by research. Critical to the community is respect. One respects research colleagues by reading and quoting their research. To ignore other’s work, or to plagiarize it, disrespects the scientific community.

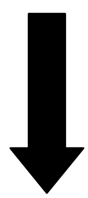
- **Respect the scientific community by reading, referencing and building on other’s work**.

2. ***Scientific thinking.*** *Rationalization* uses the intellect to argue backwards, from conclusion to reasons, i.e. the conclusion comes first then the reasons, e.g. after a mistake the mind quickly finds reasons to “explain” it, which are “after the fact” excuses or justifications. In rationalization the arrow of thought goes backwards, which adds little new. *Research* makes the intellect work forwards, from present “facts” to unknown conclusions. Socrates called this method the *dialectic* (Buchanan, 1948). He began with agreed facts, then bravely “followed the logic” wherever it led. Research drives the arrow of thought forward, creates new ideas and predicts the future.

- **Give reasons before conclusions, and derive conclusions from what went before.**

3. ***Academic format.*** Academic publications generally follow a standard five chapter logic (Perry, 1998):

   a. **Introduce Topic**
   b. **Review Theory**
   c. **Describe Method**
   d. **Analyze Data**
   e. **Discuss Results**



Both qualitative and quantitative methods fit into this structure (Perry & Zuber-Skerritt, 1994). Heading names may vary, and different publication types expand, combine, delete or contract sections, but the general logic seems common, e.g. research in progress papers have no results but still follow the same sequence. This general academic “form” helps researchers think forwards rather than backwards. It weaves a subtle path between abstract theory and concrete events (Figure 1). This path usually begins with a practical problem, then reviews relevant abstract theories to give a research question. Given that question a practical method is chosen, which creates concrete data that can be analyzed to answer the research question and impact the initial practical problem. Research is “powered” by the abstract but “grounded” in the concrete (Swan & Martin, 1994).

- **Connect ideas together to form a logical and consistent scientific argument:**
  - **Use the introduction to define the theory scope.**
  - **Use the theory review to derive a research question**
  - **Use the research question to choose an appropriate method.**
  - **Use the method to create physical based data**
  - **Use the data analysis to form conclusions about the research question**

- **Use the conclusions to discuss general implications (theoretical and practical).**

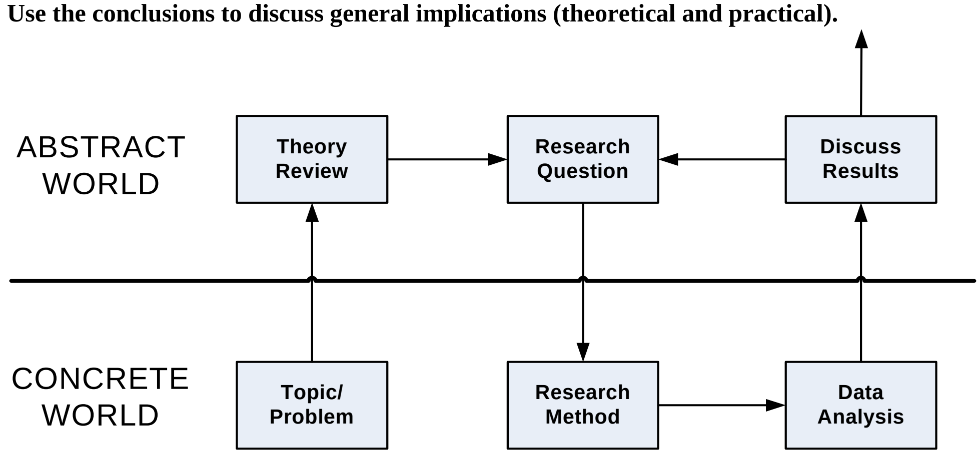


Figure 1. A Research Logic

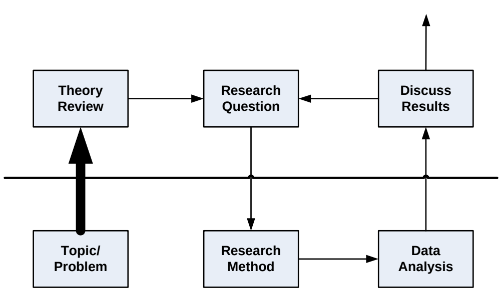
4. **Correct language** While one should not judge a book by its cover, unfortunately many do, assuming that those who cannot spell correctly also cannot think correctly. Spelling or grammar errors, especially early on, suggest a lack of professionalism, causing reviewers to look for and find further faults. Always run a computer spell-check last thing. If not using your native language, have a native language speaker check the document.

- ***Check for and fix language errors, especially early on, e.g. spelling and grammar***.

5. **Opinion statements**. Indefensible statements cannot be defended against critical review, e.g. "Technology improves efficiency" cannot be defended against the critique that some technology does not. Indefensible statements can reduce reader trust and respect, and are to reviewers like a red flag to a bull. Reduce indefensible statements by: 1. *Providing more support*, e.g. support references, 2. *Reducing the statement strength* to only what the argument needs, 3. *Reduce overstatement*, e.g. the opinion "Technology can improve efficiency" can be *moderated* ("Some technology improves efficiency"), *hedged* ("Many argue that technology improves efficiency"), or *made into a question* ("Does technology improve efficiency?") Delete or modify indefensible red flags, especially if not crucial to the argument.

- ***Avoid opinion statements, which cannot be defended against critical review***.

Introduction



The introduction is the research context, answering questions like what is this research about, why was it done and how did it originate? It *positions* the paper relative to others. Many readers use the introduction to decide whether to read on. It may include any or all of the following:

1. ***Title.*** The title briefly conveys the topic and contribution, e.g. 'Websites" is too vague, "The Usage of Websites" describes the topic, and "A Study of Factors Influencing Website Usage" adds the contribution. Also, an interesting title may attract more readers, e.g. "Website Usage: Why People Come?" may be even better.

- **A title should describe the topic and contribution in an interesting way and invite the reader to read on**.

2. ***Author(s).*** The first author is usually the person who did most of the research work and writing. In academic publishing, author order is based on contribution not seniority, so professors may put their names after their students. Put a student's name first if they did most of the work, even if the initial idea was the advisors. Students who are first authors contribute more and so learn more. All authors should understand the paper enough to present it at a conference. If not, recognize their contribution by acknowledgement rather than authorship.

- **List authors in order of contribution not seniority, where each could present the publication at a conference.**

3. ***Abstract.*** The abstract should convey meaning, e.g. "This paper gathers data relevant to current theories and analyses it" says nothing. Don't "tease" readers by stating you made a conclusion, e.g. "The paper draws some

critical conclusions." *just state the conclusion*. Don't think: "If I reveal in the abstract they won't read the paper." If your abstract gives no value, people won't read it either. An abstract usually gives at least: 1. A purpose (e.g. "This paper investigates a new technology acceptance variable."). 2. A findings summary (e.g. "User control increased user acceptance."). 3. Some implications (e.g. "Systems giving user control are more accepted.")

- **An abstract should tell the reader the paper's main purpose, results and implications.**

4. *Problem.* The reason for research is usually some practical problem, e.g. cancer research is based on the problem of cancer. Most theories have a practical base because problems activate people to solve them, so highlighting a problem invokes reader interest. If there is no problem, why was this research done? Stating the problem your research addresses answers the reader's question: "Why should I bother reading this?

- **State a practical problem which the research addresses.**

5. ***Topic.*** The topic is the general subject area. It tells readers if your paper is in their area of interest. Even if the title gives it, state your topic early. Never assume, as authors familiar with a topic may do, that the topic is obvious. *It is not*. Choose *one* topic, define it, and refer to it with consistent words throughout the paper, e.g. technology acceptance, technology diffusion and technology evaluation are different topics with different target audiences. Don't "morph" a stated topic into something else as the paper processes, e.g. stating the topic is technology evaluation (of existing products), then presenting market research data (of potential products).

- **Choose <u>one</u> topic, and refer to it consistently throughout the paper.**

6. ***Purpose.*** The purpose statement expands the topic (what the paper is about) into what the research aims to achieve. Editors expect a sentence like: "This paper aims to …" within a page or two. Finding several different purposes is a bad sign, as a paper should have a one purpose, stated in one sentence. More is not better when it comes to purposes. Reading the purpose addresses the readers question "What does this paper hope to achieve?"

- **State the research purpose in a single sentence within the first few pages.**

7. *Publication type.* Research publications have many forms, e.g. *theory* papers with new models, state of the art *reviews*, *empirical* papers with data, or *method proposals*. Research has three sources of value: *information*, *logic* and *past research*. Information is here meant what the researcher collects from the world. Logic is analysis that combines ideas and information to create new knowledge. Past research is past information and logic, often distilled into theories. All three sources are not necessary, e.g. reviews analyze past research but present no data. Identify your publication type early, so readers know what to expect, e.g. a research proposal should not say: "This paper investigates …" as readers will be disappointed to later find no investigation is presented.

- **State publication type (e.g. review, proposal or empirical study) early so readers know what to expect.**

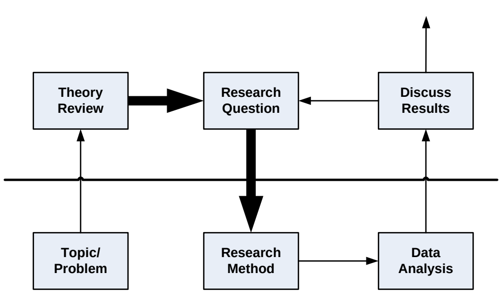
8. *Background.* A little background history can "warm-up" readers to a topic, as unarguable historical facts set the stage, and explain how the current situation arose. Good papers always "tell a story", and a background history helps connect the present to the past.

- **Give a brief background history introducing the research.**

9. *Target audience.* The *relevance* of research is indicated by the number of people interested in it, and is distinct from its *rigor* or scientific quality. Defining the target audience by statements like 'This paper will interest software users." helps those readers relate to it. Stating a target audience also helps define the way the paper is written, e.g. is it for a technical group or a user group?

- **State the target audience, i.e. who is expected to read this paper.**

Theory



This section reviews relevant research, analyzes agreements and contradictions, chooses a theory base and formulates a research question. It may include any or all of the following:

1. ***Scope.*** Defining topic scope is like drawing a line around a territory, to define what is in and out of the paper. State not only what the research is about, but also what it is *not* about. The scope is often poorly stated by new authors, who like to wander freely in areas irrelevant to their topic.

- **Define the boundaries of the research study and stay within that scope**.

2. ***Literature review.*** Every topic sits within a previous knowledge context, which must be recognized. A "State of the Art" literature review must *honestly* summarize current research, like a reporter reporting facts, including those against your view. Aim to be *complete*, and cover those important in the field. Finally *analyze* themes, agreements, conflicts, contradictions or gaps. Don't just sequentially summarize what others have done, e.g. A

did this, B did that, C did the other, etc. Structure the review by issues, e.g. compare and contrast many authors on one issue, then repeat for other issues.

- **Review and analyze the literature by issues (agreements/contradictions), not as a sequential list of other's research.**

3. ***Topic construct/ Dependent variable (DV).*** A good literature review defines research *topic construct(s)* or *dependant variable(s)*, e.g. the construct "Web Use" if measured by web hits or time on site is a variable. Don't confuse the topic construct with what causes it, e.g. the topic "Web Site Effects" begs the question "Effects on what?". It could be customer relationship, user acceptance, web usage, or company marketing any one of which is a study in itself. This thesis wandered across many topics and gave weak results because the literature review failed to well define the topic construct.

- **Clearly define the main topic construct (dependent variable), which the research is primarily about, and distinguish it from other constructs or variables.**

4. ***Causal construct/ Independent variable (IV).*** A good literature review identifies constructs or variables that affect the topic. In a causal relation, those affected by others are *dependent* (e.g. web usage), and those that cause change are *independent* (e.g. web site ease of use). A variable can be both dependent and independent, e.g. ease of use affects web site usage which in turn affects web site sales. *Moderating variables* alter a causal effect, e.g. user age may moderate how ease of use affects usage, as young people learn faster. *Intervening variables* mediate causal effects, e.g. user attitude may intervene between ease of use and usage. In describing theoretical relations, or "effects", distinguish what is being caused from what is causing.

- **Distinguish what is causing from what is being caused in causal relations between constructs.**

5. ***Conceptual framework.*** Theories connect abstract constructs, and so can describe innumerable specifics, e.g. the law of gravity applies generally to any falling object. While abstract theory disconnected from concrete reality is dangerous, all research needs a *theoretical framework* to be generally useful. Collecting data without theory often wastes time and effort – like a lost person who wastes time wandering about. Use the literature review to choose the conceptual framework you used to direct this research, e.g. an existing theory, a theory combination, a theory modified by you, or a new theory of your own.

- **State the conceptual framework this research will use, ideally with a diagram.**

6. ***Research question.*** The research question (RQ) is the core of your research. It comes at the end of the literature review because one must know what others have done to ask a question that is not already answered. It comes before the method, because one cannot choose a method to answer a question until one knows what the question is. <u>Derive</u> the research question, which should: 1. *Be a single question* (stated in a single sentence). Different questions need different studies to answer them, though one may break a RQ down into sub-questions, a., b., c. etc. 2. *Put a real choice*, e.g. "Does fear make one afraid?" is a circular as fear by definition is being afraid, so this is like asking "Is 1 = 1?" Real questions have more than one possible answer, i.e. are "falsifiable" by data. Research tests theory by asking risky questions. 3. *Be focused enough* to be feasible to answer, e.g. "What affects life?" is a bad RQ as everything affects it. The more focused an RQ is, the more likely the research is to finish.

- **A research question is a single sentence (clear), with many possible answers (falsifiable), focused enough to allow feasible data collection (testable).**

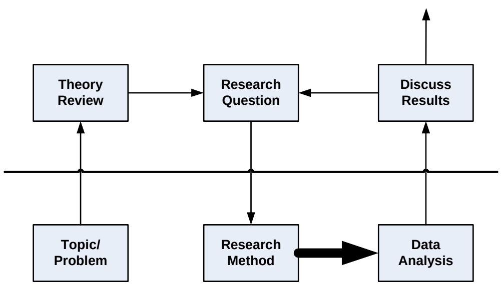
7. ***Research type.*** Empirical research (qualitative or quantitative) gathers information from the world. It can discover, describe, connect, or causally link constructs. Its types are exploratory, descriptive, correlational and experimental: *1. Exploratory research*, like grounded theory, uses data to "uncover" initially unknown or poorly defined construct(s), so is useful for new topics*. 2. Descriptive research* aims to better define construct(s), e.g. questionnaire factors, and is useful for evolving areas. *3. Correlational research* shows connections between constructs, but not what causes what, e.g. longitudinal studies of web site usage. Use it where one cannot realistically manipulate variables, *4. Explanatory research* establishes cause and effect, e.g. by manipulating a *treatment* (independent variable) and measuring its *effect* on a dependent variable in "experimental" conditions. While research *control* usually increases in the order given, *realism* often decreases in the same order, e.g. case studies are usually more realistic than experiments. Exploratory research is the most widely applicable, and explanatory studies the most restricted in use. Different research types are not "higher" or "lower", merely more or less appropriate to different situations. To use exploratory research for a well established topic is as misplaced as to do an experiment in a new and poorly understood one.

- **Choose a suitable research type (exploratory, descriptive, correlational or explanatory) that is also feasible to do.**

8. ***Hypotheses*.*** Explanatory research restates the RQ as one or more hypotheses, i.e. abstract statements whose opposite data can falsify, e.g. the RQ: "Do subjects prefer polite software?" gives the hypothesis "Subjects will use polite more than impolite software", and its "null" hypothesis "Subjects will respond equally to polite and impolite software". The null hypothesis usually assumes a random data distribution, so statistics can be used to estimate probability. If the null hypothesis is unlikely, at say less than 1 in 100 chance (p<0.01), we reject it, and its hypothesis opposite, is "supported". Note that this logic does not "prove" the theory, but opens it to falsification. Argue for and then state each hypothesis one at a time.

- **Argue for and state each hypothesis, so that the data results can falsify its opposite.**

Method



The research method states how the research question was put so that physical world data can answer it, and can include any or all of the following:

1. *Methodology theory.* If the method is uncommon or new, briefly present its theory, e.g. factor analysis theory, interpretive method theory or conjoint analysis theory. The method theory is not your research theory, so keep it brief – readers familiar with factor analysis don't want pages of factor analysis textbook theory. While your *research theory* needs extended coverage, your *method theory* does not. Refer readers elsewhere for details.

- **Only present methodological theory for a new method, and even then only briefly.**

2. ***Qualitative vs. Quantitative Information***. The basic principles of research (validity, reliability, replicability, generalizability, etc) apply both to qualitative and quantitative information. Data types are not in competition, though the jargon differs, e.g. qualitative "constructs" vs quantitative "variables" are different names for abstractions. Qualitative studies can better convey meaning but may struggle for precision, while more precise quantitative studies can struggle for meaning. Either way, justify the main data type gathered. A *mixed-method approach* can gather complementary qualitative/quantitative data, e.g. interview subjects after an experiment.

- **Use qualitative, quantitative or a mixed-method approach as appropriate.**

3. *Pilot study.* Research is complex, and one mistake can nullify the project. A pilot study tries out the method and research tools on a few cases to uncover problems, e.g. poor questions. Briefly report pilot test data, and state how the method was modified as a result, e.g. how research tools like questionnaires were improved.

- **Report how pilot testing improved the research method or tools.**

4. ***Research Design.*** The research design is *the method logic that ensures that the data collected correctly answers the research question*, e.g. case study design, repeated measures design, longitudinal design, etc. Both qualitative and quantitative methods try to ask questions in an *unbiased* way, so the answer is from the world, not researcher bias. Good research design ensures the right answer to the research question is obtained. Different designs have different requirements, e.g. in repeated measures design, where subjects try first one software product then another, product order is randomized, so it does not affect the results. Many experimental designs require *subjects to be randomly assigned to treatments*, e.g. subjects evaluating two web sites cannot choose the one they view, lest differences found be due to this *spurious* reason (their preference). Qualitative research is equally vulnerable to spurious effects, e.g. the effect of the researcher watching.

- **Explicitly state the argument that method generates data that really answers the research question**

5. *Control group*.* The control group are subjects who do everything the same but do not receive the treatment, e.g. in medical research they receive a placebo sugar pill not the new drug. This controls for unknown influences. Subjects must be randomly allocated, i.e. subjects cannot choose to be in the control group. A control group is important if subjects know they are being observed, e.g. in the "Hawthorne effect" experimenters found that painting a room a brighter color improved work rate, but later found painting it dark had the same effect! What improved the work rate was not the painting but *being observed*. A control group recognizes such problems.

- **Randomly allocate subjects to a control group to reduce spurious effects**

6. ***Measurement.*** State how you actually measured/investigated each variable/construct, as information can be gathered in many ways. Justify your measurement method, whether taking qualitative or quantitative measures. Qualitative research may reference methods like action research, case study, grounded theory or ethnography.

- **State how you measured what you are trying to measure, and why you chose this way to gather data.**

7. ***Reliability.*** Good data should be as reliable as possible, i.e. change little when measured at different times or with different people. Reliable measures are stable, with few errors caused by the measuring itself. Qualitative studies use standard methods, keep detailed journals and analyze self-consistency to get reliability. Quantitative studies use 1. *Test-retest* reliability checks how a measurement changes if repeated, e.g. give a test then give it again later, or 2. *Split-half* internal-consistency reliability checks if the measure is consistent within itself, e.g.

compare the first half with the second half of a test. Reliability coefficients like Cronbach's alpha are accepted if 0.85 or higher. One way to ensure a reliable measure is to use one that someone else has tested.

- **Argue why the measurements are reliable, e.g. by precedence, test-retest or split-half checks**

8. ***Validity.*** Good data should be as valid as possible, i.e. *measure what it is supposed to measure*, e.g. foot size is a reliable but invalid measure of intelligence. A valid measure one that is agreed to represent its abstract construct. Validity can be established in three ways: *1. Content validity,* where the construct content is self evident in the measure, e.g. asking "Did you enjoy the web site?" as a measure of web site enjoyment. *2. Criterion validity,* where one measure is validated against another already accepted as valid, e.g. validating a web clicks "interest" measure against purchase data. *3. Construct validity,* that the measure is a single construct that "hangs together" (convergent validity) and separates itself from other measures (discriminant validity), e.g. a variable like "Circumstances of the Economy" lacks construct validity as it is not a unitary variable. One way to ensure a measure is valid is to use a tool someone else has validated.

- **Argue why the data is valid, based on content, criterion or construct validity**

9. ***Unit of research.*** The unit of research, or *case*, is one information collecting act. Often the data case is one subject, but it can be a transaction or a group. e.g. in an online group voting study the case could be the <u>vote</u> (choice), the <u>individual</u> (satisfaction), or the <u>group</u> (agreement), or all three. In a raw data table, where the variables are columns, each line or row is a single case. The case affects the number of measurements (N) of the analysis, e.g. 90 subjects could give 900 votes (N=900), 90 satisfaction ratings (N=90), or 18 five person group agreement ratings (N=18), depending on the unit of research used.

- **Specify the unit(s) of research of your study, i.e. what is one data gathering "case"?**

10. ***Procedure.*** Describe the information collection procedure step by step, whether face-to-face, by telephone, by self-administered questionnaire or website, etc. e.g. "After entering the room subjects were read the study instructions (Annex A), then signed the consent form (Annex B)…" Also describe procedure deviations, e.g. subjects who left the room or talked to a friend, and what was done.

- **Describe in sequence the data collection procedure, with any tools used, e.g. introduction script**

11. ***Task*.*** Describe what subjects had to do, e.g. give the task instruction script given to the subjects. Also describe any training given (to reduce initial skill variations).

- **Describe the task and any instructions involved.**

12. ***Question design*.*** Good questions reduce error variance from subjects who just "tick the boxes". Good questions are: *1. Understandable*, e.g. simple words and grammar, *2. Unambiguous*, e.g. don't use double-barreled questions, *3. Unbiased*, e.g. a question phrased "Don't you agree that …?" is biased. The same question may be asked both negatively and positively to avoid "Yes saying" bias. *4. Answerable*, e.g. the user may not know "How good is the national budget?", and *5. Not offensive*, e.g. some may not answer rude questions.

- **Design questions that are understandable, unambiguous, unbiased, answerable and not offensive.**

13. ***Response scale design*.*** Multi-choice question response scales should be 1. *Easy to use*, *2. Unbiased* (do not imply a preferred answer), *3. Exhaustive* (cover all answer choices) and 4. *Sensitive* (produce varied responses). Studies suggest that while more options give more information, above about 5-7 options, scale sensitivity and reliability increase little.

- **Design response scales that are easy to use, unbiased, exhaustive and sensitive.**

14. ***Sample generalizability.*** While a study collects information from a *sample*, conclusions invariably apply to a *population*, e.g. a study of college students using browsers may conclude how "people" use browsers. The sample is the students who gave the data, and the population is "people" in general, to whom conclusions are addressed. The researcher can argue this *generalization* from sample to population by showing the sample is: 1. *Big enough*, 2. *Represents* the population, and 3. *Unbiased*, e.g. 3000 subjects chosen at random with the same demographics as the population. Else one must reduce the generalization, e.g. a qualitative study may *suggest* possible general implications.

- **State why sample information has population implications, e.g. the sample is unbiased, big enough, and represents the population**

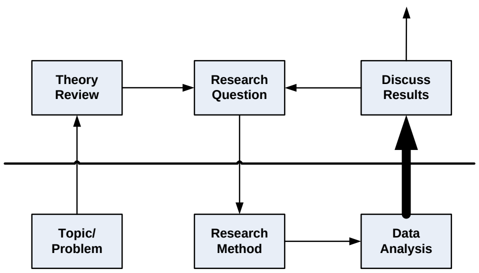
15. ***Sample size*.*** Some experimental designs are summarized as independent variable grids, e.g. how perceived usability affects web site usage for males and females could be *2x3 study* of Gender (Male/Female) by Perceived Usability (High, Medium, Low) upon Web Site Usage. In such designs each cell needs about 15 subjects, e.g. a 2x3 study has 6 cells and so needs at least 6x15 = 90+ cases, while a 5x5x4 study might need 1,500 subjects. The methodology limits the number of variables that can b e investigated at once.

- **Check the sample is big enough for the question(s) asked of it.**

16. ***Replicability.*** Replicability means the research can be repeated by another researcher. Method descriptions like sampling method, missing values, etc. let others replicate the research. Give copies of research tools, like questionnaire, task script, or subject instructions, in an Annex.

- **Describe the research method well enough so another researcher can repeat it.**

Results



The results section analyses the raw data to give conclusions, and can include any or all of the following:

1. ***Error type.*** The worst result in research is not negative data (that contradicts theory), but data that shows nothing (nil results). Good research can give negative results, but nil results suggest error "noise" drowned out the effect, e.g. an unfocused RQ, or a method that confounds constructs. In research a Type I error accepts a false result, and a Type II error rejects a true result. Insufficient research *rigor* gives Type I errors of commission, and insufficient research *sensitivity* gives type II errors of omission. Research must be *rigorous* enough to avoid false results, yet still *sensitive* enough to find true results. Improve research sensitivity by methods that enhance responses (e.g. motivating subjects with a competition), that reduce subject error (like subject training), or use more sensitive statistics. Unfortunately reducing one error type tends to increase the other, so reducing errors of commission to zero will increase errors of omission to 100%, so the only way to make no errors is to do nothing.

- **Improve research rigor to avoid Type I false claim errors, and improve research sensitivity to avoid Type II null result errors**

2. ***Data Conversion.*** Describe how the study raw data was converted into descriptive results, e.g. transcribing tapes or translating computer data. In particular, what was left out? Attempts to gather data can give three outcomes: 1. *Valid result*, 2. *Nil response* (NR), or 3. *Not applicable (*NA), e.g. asking someone "Why did you buy your mobile phone?" may give a reason, they may walk away (NR), or say "I don't have a mobile phone" (NA). Both NR and NA are *missing values.* State the missing value numbers and how they were dealt with.

- **State how raw data was converted to descriptive data, and how missing values were handled.**

3. ***Demographics.*** To show the sample is representative, give sample demographics, e.g. number of males vs. females etc. to compare the sample to the population of interest. Even if your sample was one person, was that person typical?

- **Present sample demographics and compare them to population demographics.**

4. ***Information type.*** How information is handled depends on its type. Qualitative information, like a book, requires human interpretation. Quantitative information being numbers uses statistics. Which statistic to use varies with information type: **1.** *Interval*, a continuous number series like 1,2,3,… **2.** *Ordinal*, a series of ranks, like 1st, 2nd, 3rd, etc, **3.** *Categorical*, a set of categories, like PC, Laptop and Handheld. Information type affects information analysis, e.g. measuring computer experience in years (interval data) gives more information than self-ratings of Expert, Competent or Novice (categorical), which involves fewer choices. Yet the latter may be more sensitive to reality (as many years may not make one an expert).

- **Analyze information according to type (qualitative, interval, ordinal, categorical)**

5. ***Descriptive summary.*** Give a descriptive summary of what was found, whether as common text themes, or as summary numbers. Thousands of quantitative data points can be summarized by frequency (N), mean and variance. Round off the data appropriately to the error, e.g. 3.74 not 3.742356, even if the statistical analysis gives the latter. Draw conclusions from the summary, e.g. an effect's direction.

- **Give a descriptive summary of the information (e.g. themes, or N, mean and variance) and comment on it.**

6. ***Analytic statistics*.*** Analytic statistics show an effect's *strength* or *significance*. For two-variables, strength is how much the variables correlate, and significance is the probability it was just chance. Variables may correlate weakly but significantly, e.g. a weak correlation over a million subjects may be significant, i.e. a weak $r = 0.50$ (strength) but a strong $p<0.01$ (significance). Conversely a strong correlation for a few subjects may be insignificant. Which *strength* statistic is used depends on information type: 1. For two interval variables use Pearson's r, 2. For categorical independent variable and interval dependent variable, use Eta, 3. For both ordinal use Gamma, 4. For both categorical use Phi or Lambda. The *significance* statistic also depends on type: 1. For two interval/ordinal variables use a t-test, 2. For independent variable categorical and dependent variable interval use F-test, 3. For both categorical use Chi-squared.

- **Select analytic statistics for strength (e.g. Pearson's r, Eta, Gamma, Phi, Lamda) and significance (e.g. t-test, F-test, Chi-squared) based on data type.**

7. ***Assumptions.*** Any analysis has assumptions, which must be stated, e.g. F-tests assume normally distributed responses, similar measure variances (homogeneity), and independent measurement. Assumptions must be tested and mentioned.

- **State and justify analysis assumptions.**

8. ***Findings.*** In the results analysis, argue each finding individually, one at a time, directly from what was found. Do not simply state findings without argument.

- **Argue each finding individually, one at a time, from the research data or information.**

9. ***Tables*.*** Tables which summarize results need a title at the top, usually topic variable by one or more causal variables, e.g. "Usefulness by Usability". Table headings must name the row and column variables, whether for: 1. *Frequency Tables* or 2. *Mean Tables.* Reference the table in the main text, e.g. "See Table 1."

- **Tables need a title, say topic by causal variables, row/column headings, and a reference in the text.**

10. ***Frequency tables**** Frequency tables, or cross-tab tables, usually show a *categorical* topic variable (DV) by a *categorical* causal variable (IV), e.g. Usefulness (topic) by Usability (cause) (see Table 1). The percentages add up to 100% across the row, and show how the topic variable distribution changes from one row to the next.

- **Frequency tables show topic variable percentages that add up to 100% for each row, and vary between rows**.

Table 1. Usefulness by Usability

	Usefulness		
Usability	*Low*	*Medium*	*High*
Low	47%	25%	28%
Medium	26%	51%	23%
High	22%	26%	52%

11. ***Mean tables**** Mean tables show an *interval* topic (dependent) variable broken down by *categorical* row/column causal variables, e.g. % acceptance (topic/DV) by Usefulness and Usability (causal IVs) (see Table 2). Now the percentages of Table 2 do not add up to 100%. Each cell is a topic variable <u>mean</u> of several subjects/cases, and the table shows how this dependent variable changes with row/column independent variables.

- **Mean tables usually show a topic variable cell mean varying by row/column causal variables**.

Table 2. Percentage Acceptance by Usefulness by Usability

	Usefulness		
Usability	*Low*	*Medium*	*High*
Low	47%	55%	68%
Medium	53%	67%	75%
High	58%	70%	86%

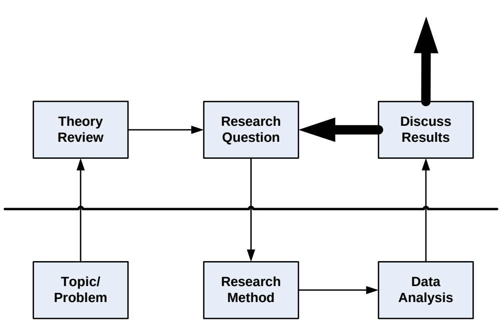
12. ***Graphs*.*** Graph type also varies with information type, e.g. both variables interval suggests a line graph, with a causal (X-axis) independent variable, and a topic (Y-axis) dependent variable. A categorical causal variable suggests a bar graph, or a pie graph if the topic variable categories add up to 100%. One may use a line graph for categories if continuity is implied, e.g. Jan, Feb , etc implies time.

- **Use graph types (line, bar or pie) depending on information type, and label each graph axis clearly**.

13. ***Summarize conclusions.*** Summarize the findings as a numbered or bulleted statement list that helps the reader see all the results in one place. Experimental studies list all the hypotheses as supported or not supported. Below this, answer the research question raised earlier as a foundation for the next section's discussion.

- **Summarize the main conclusions in a numbered list, and answer the research question.**

Discussion



The discussion section considers how the conclusions affect the big picture, and can include any or all of the following:

1. ***Research Contribution.*** A paper should state its research contribution, i.e. what it adds that is new. Make clear what comes from others and what is your own. Contributions include: 1. *Adding* to knowledge currently lacking, 2. *Resolving* a theory conflict, 3. *Specifying* details of known work, or 4. *Summarizing* current work. Don't leave readers confused regarding the contribution, i.e. answer the question "W*hat value does this paper add?"*

- **Distinguish the value the research adds, apart from what others have done.**

2. ***Limitations.*** Limitations are the weaknesses of the research, e.g. small sample. They are the assumptions of your scientific argument that may not be true. Just as every argument has assumptions, and a "foolproof" argument is simply one whose assumptions are undeclared, so every research has limitations. In research, it is better to declare limitations than to try to hide them, so then they can be taken into account. Knowledgeable readers will see the limitations anyway, and wonder if you did not mention them from ignorance.

- **Declare rather than hide research limitations, i.e. honestly criticize your own research.**

3. ***Implications*** Note the implications of the conclusions for both theory and practice. Implications include challenging theories, supporting theories, changing current views, suggesting new points of view, changing current practices, and enabling new applications or practices. How does this research fit with current trends?

- **Discuss probable and possible implications of the findings for both theory and practice.**

4. ***Future research.*** Help the research community by suggesting how it could build upon your work. Imagine future research possibilities and envision possible future outcomes. Consider what is possible as well as likely, as in this part of the publication one can freely imagine, since many things that once seemed very unlikely have still actually occurred, e.g. the Internet.

- **Suggest future research possibilities to help other researchers.**

5. ***Acknowledgements.*** It is considerate to acknowledge anyone who helped you, whether an assistant who helped gather data, or a colleague who gratuitously commented. It can be important to acknowledge any grant support.

- **Acknowledge those who have helped you.**

6. ***References.*** Some reviewers judge the quality of a publication from the quality of the references, looking for things like: Are journal article page numbers given? Are author names spelled correctly? Are major authors in the field referenced? Are the references up to date? Are there journal references, not just books, web sites or magazines? One need not be too "trendy", with only recent references, as research is not a fashion show.

- **Ensure the references reflect the quality, breadth and up to date nature of the publication.**

Final Points

Ask the following general questions (relevant sections are given in brackets):

1. **Is the research relevant? –** Useful to others?? (*Introduction, Discussion*)
2. **Is the research rigorous? –**Is it methodologically correct? (*Method, Results*)
3. **Is the research generalizable? –** Is it widely applicable? (*Theory, Method, Discussion*)
4. **Is the research logical? –** Is it consistent and a logical sequence of ideas? (*All*)
5. **Is the research well written**? **–** Is it interesting and understandable? (*All*)

Figure 2 shows how research begins broad, focuses in to a RQ, then expands out again. The linchpin of this process is the research question, perhaps why finalizing it can take up to half of the total research time.

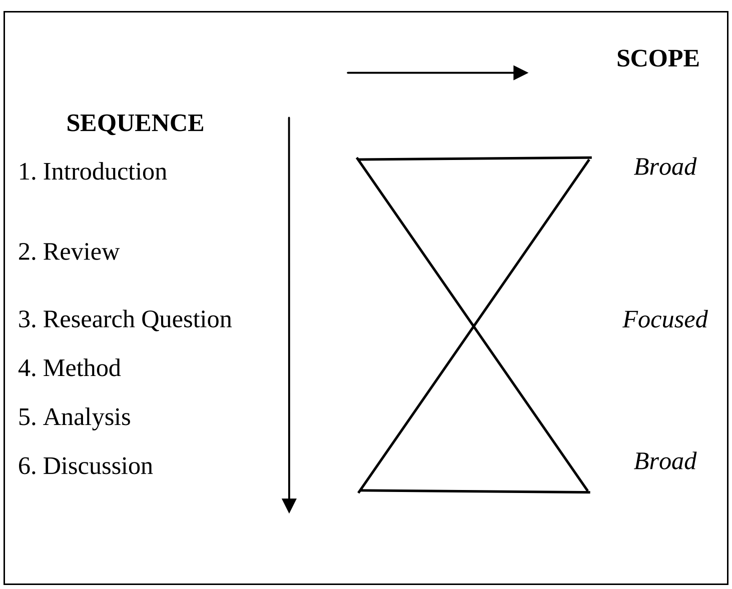


Figure 2. Research scope by Research logic sequence

Usage

The checklist is designed to be used in student/advisor discussions rather than as a stand-alone document. Current use suggests students find it a helpful "map" to a complex process, that forewarns of issues to come. Advisors find it useful to focus a discussion, especially for students who selectively ignore issues they find inconvenient or difficult.

Further work

In seeking common knowledge elements across different disciplines this paper assumes commonality exists. Perhaps different fields have different methods and there is no "scientific core". The assumption that all research has a common base cannot be proved, but many Universities regard PhD research as trans-disciplinary. Further work with this checklist may suggest that research does have common principles. Yet in presenting the checklist to students/advisors, qualitative and quantitative researchers will certainly have different profiles. This may allow checklists tailored to different research types, with irrelevant elements removed. Another approach is to analyze conference or journal rejection reasons to see what percentage use the checklist points. Overall it is hoped that this checklist improves and advances research quality

Acknowledgements

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