Advice to new Research Students

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This is an initial document to be distributed to research degree students. Will be revised and further refined as we go. You should do a research project to earn a Masters by research or a PhD degree. A research project should 1) address a specific research question, 2) use valid research method(s), 3) validate your results, and then 4) draw a conclusion.

1. How to develop a research question

For computer science research questions, please read the attached "1_CS_ChoosingAResearchProblem.pdf" for general discussion of how to decide about a CS research question. You can also review the slides in "1_brans_Defining a research question". For where to search for questions, the following steps are suggested:

1. Define a general topic of interest and consult with possible supervisors to narrow down.
2. Read through recent publications and focus on introduction and conclusion/Future work sections. Your question is in the Future work. If you find something interesting read the paper thoroughly and all required background information.
3. Make a list of all journals, conferences in this topic area, and read through the call for papers. This is usually where all current research areas of interest are listed. This will help you avoid choosing an area without much research activity or interest.
4. Read recently published MSc and PhDs dissertations, and focus on the future work.
5. Finally you can compile a list of text books (hopefully recently published as well) that can give more in depth background to complete your literature review.

While trying to choose a topic of interest, it is good to learn about what researchers world wide are considering to be a computing grand challenge. Starting from a grand challenge, you define a specific problem or limitation to address, and gradually solve, optimise, or at least evaluate and compare. It is very difficult to address a major project without working on small building blocks first and build on other people work. This where citations and references play a central role in your academic honesty and team player attitude.

Its good to visit the following sites for ideas about current grand challenges in computing or do a web search for more current links:

1. http://193.62.125.70/Complex/grand_challenges/
2. http://www.ukcrc.org.uk/grand-challenge/index.cfm
3. http://en.wikipedia.org/wiki/Grand_Challenge

This reference discuss general research questions:
http://science.dodlive.mil/2010/10/04/defining-the-beginning-importance-of-research-questions-hypotheses/

The development of a well-designed and concise research plan is the key to any successful research project. Good research plans provide a detailed map for the conceptual and logistical frameworks that serve as the support structure for your research project.
An important first step toward providing a sound conceptual foundation for your research project is the development of solid research questions and hypotheses. This process typically begins with a preliminary review of the existing literature for your topic. A research question poses a relationship between two or more variables but phrases the relationship in terms of some question.

A well researched and thought out question will help focus your ideas and ensure you are collecting the appropriate data. This is a critical step in the research process. The research question determines what, where, when, and how the data are collected and is an important link between the conceptual and logistic aspects of your research plan. While reviewing the current literature and formulating your ideas, keep the following questions in mind:

- Why is this research important? What is it that we don't know or fully understand?
- What have other researchers in my field done?
- What areas need further exploration?
- Can my study help fill in these gaps or lead to greater understanding?

Once your research questions are firmly established the next logical step is to develop a set of hypotheses based on the questions posed by your study. A hypothesis is a declarative statement that attempts to predict the relationship between two or more variables based on statistical consideration.

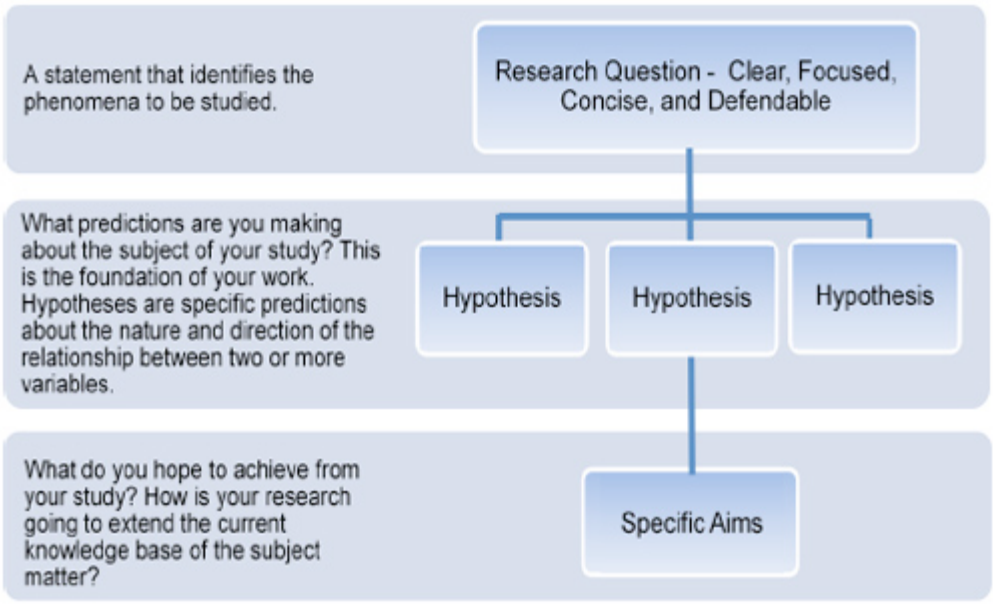
Strong hypotheses:

- Give insight into the proposed research question;
- Are measurable and testable;
- Are developed directly from the experiences of the researcher;
- Should be concise, as a rule, no more than three hypotheses should be proposed for any given project;
- There should be a well-founded rationale for all proposed hypotheses.
    - Why did you make these predictions?

- Why are they important?
- Provide alternative possibilities for the hypotheses that could be tested.
- Why did you choose the ones you did over others?

You might find it helpful to consult a statistician once your research questions and corresponding hypotheses are finalised to discuss experimental design, data collection, and statistical analyses.

Ultimately, the success and quality of research is a direct product of the amount of time and effort invested in the development of your research ideas. Thorough planning and design will help facilitate data acquisition and analysis and help alleviate research stress during the next phase of the research process.



2. Research Methods

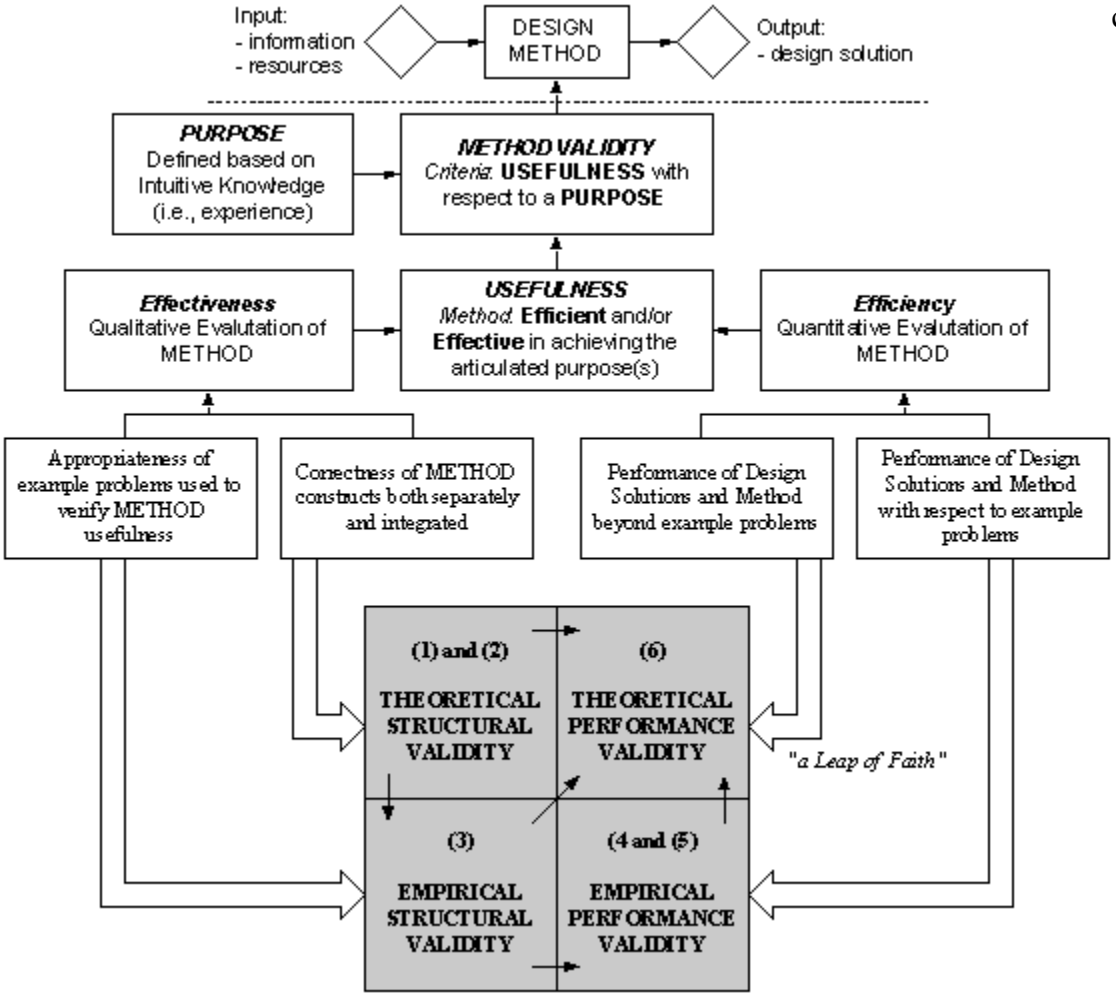
Often research methods are evaluated using the social science research methods with focus on qualitative and quantitative surveys results analysis and verifications. However, computer science research tend to be more experimental. Please review the "2_CS_ResearchMethods.pdf" included in the pack for a discussion on computer science research methods. Please review the attached paper "2_Research in computer science- an empirical study.pdf" for a qualitative study for the publications between 1995 and 1999 in 13 leading research journals in the CS field.

The research pack include several publications about case studies as research methods. There are also publications about comparative analysis.

3. Results Validation

Resource (3_scientificApproach.pdf attached):
http://www.variant.se/acthesis/acPhD_3_Scientific_Approach.html#Pedersen2000a

Two important dimensions in evaluation are verification and validation. Verification deals with the truth or accuracy and the predictive power of theories, methods, and models, whereas validity deals with their relevance and meaningfulness (Warell, 2001). Olesen (1992) suggests that research results should be evaluated with respect to five aspects: internal logic; truth; acceptance; applicability; and novelty value. Internal logic evaluates the condition that the results are based on known and accepted theories, and that there is a connection between the starting point, the hypothesis, and the result. Truth refers to an assessment regarding the ability of the theoretical and practical result to be used in order to explain "real" phenomena. Acceptance is an evaluation of whether other researchers accept the proposed concepts and/or theories as well as of whether practitioners and professionals accept and are able to use the theories, concepts, methods, and tools based made available through the results of the research. Applicability evaluates whether the use of the theories, concepts, methods, and tools provides for an increased probability for success with repeated use. It will not necessarily lead to success every time, but over a period of time it will give better results than if not used. Last, novelty value is an assessment that the research results involve a presentation of new solutions or introduce new ways to look at a particular problem. If the research result satisfies all five criteria, then it is possible to view the results as valid with quite good accuracy.



4. Drawing a Conclusion

Your conclusion should list your findings and should be supported by your results, and your results validation and verification. It should detail the knowledge contributions based on the outcomes of your research work. As a researcher in a specific topic, you know the limitations, literature gaps, or the future research points based on your findings. Besides having a good knowledge contribution, the future work points are most valuable by new researchers, or you yourself in your future work.

In the final writeup of your thesis, the conclusion need to be summarised in the abstract, listed in the introduction chapter, and discussed in detail in the conclusion chapter. Similarly in a specific publication, your abstract, introduction and conclusion sections should contain your final conclusion in proportional level of detail to the final writeup.

5. General Requirements

1. Have a copy of the CCIT-AASTMT research degrees policies and requirements and conform to them.
2. Weekly or monthly meetings with supervisors based on the requirements and their magnitude, and any circumstances,
3. Biannual progress reports
4. Submit a complete research proposal before your 4^{th} year from enrolment.
5. Publish a paper in a reputable CS conference or journal before your 5^{th} year from enrolment.

6. Documents Required Outlines

Technical writing for CS students and graduates is a skill that should be taught and acquired over years of education and practice. Please review the attached "6_CSWriting.pdf" and "6_CSTechnicalWriting.pdf" for general CS technical writing skills. Please review "6_Writing for Computer Science.pdf" by Justin Zobel and "6_Scientific Writing for Computer Science Students" by Wilhelmiina H¨am¨ala¨inen.

References and citation are part of any writing process and are considered one major factor in evaluation. Academic honesty require that you cite and properly include the detailed reference for all your sources. Please review chapter 2 in "6_Scientific Writing for Computer Science Students.pdf" and page 20 in "6_Writing for Computer Science.pdf" for more details about citations and references.

The following are the required outline required in the program.

Research Proposal Document Outline:

Title Page
Table of Contents
List of Illustrations (if necessary)
Project Summary
Introduction
    Rationale and Significance
    Problem Statement
    Motivation
    Aim(s)
Literature Review
Plan of Work
    Task Breakdown
    Software and Hardware Specifications (used for development)
    Software Prototype Definition (if appropriate)
    Evaluation Plan
    Time Schedule
References
Vita
Appendices (if necessary)

Biannual Progress Report:

Problem Statement (if updated)
Last 6 Months Achievements
    Research Methods (If updated or what is applied so far)
    Results (What is available so far)
    Results Verification (What is analysed so far)
    Conclusions (What is available so far)
Next 6 Months Plan
    Research Methods (what is planned)

Results (What is expected to be available or generated)
Results Verification (What is planned to be done)
Conclusions (What is expected to be proved)

Printout of any Publication(s) or drafts written so far.

Research Publication Outline:

Abstract
Introduction
Rationale and Significance
Problem Statement
Literature Review
Materials and Methods
Design of the Investigation
Software and Hardware Specifications
Procedures
Methods for Observation and Interpretation
Results
Discussion (Results Verification)
Conclusion
References

Final thesis writeup Outline:

This should be smiler to the publication outline, but more elaborated and include complete information required to understand the contents. Based on the topic, chapter titles may be different, and more chapters can be added as required.

7. Presentations

Your presentations should have the same outline as your publication or final thesis writeup. However, you should limit your slides to the time available to you. The minimum research presentation outline should be:

Introduction:

- give some background information and interest your audience in your topic,

Methods:

- explanatory and relevant to your conclusions
- good place to use diagrams, flowcharts

Results:

- tables and graphs are often good to summarise results
- several simple graphs can be better than one really complex one
- graphs and tables can be imported from word and excel

Discussion:

- main body of your talk
- Discuss results and conclusions which can be drawn from them and any other information that is relevant to your conclusions

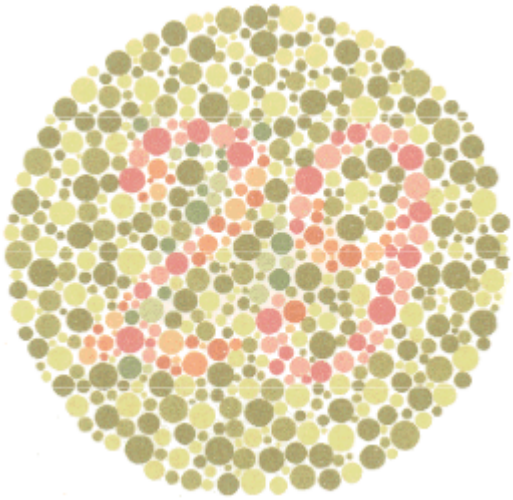
Conclusion:

- must bring the whole thing together and present a summary
- try for an obvious "end" or take home message
- good place to insert thank-yous

General Rules:

- 1 slide per minute (or fewer!!)
- 166 rule:
  - 1 topic per slide.
  - 6 point per topic.
  - 6 words per point.
- The basics:
  - Concise content.
  - Logical order, good flow.
  - Supported by illustrative graphics.
- Basic understanding of design:
  - Fonts:
    - Serif fonts (like Times New Roman) have a serif added to the shape, which creates a visual line which is easier for the eye to follow, and so is used for blocks of text.
    - Sans serif fonts (like Arial) have no serifs, and are usually used for titles and small amounts of text.

        - Decorative fonts are fun, but can be very hard to read. Use for titles only, and with caution.
        - [C:\winnt\fonts] take fonts with you!
    - Colour:
        - Using colour well can enhance your message.
        - Poor choice of colour will obscure it!
        - It all comes down to CONTRAST.
    - Contrast:
        - Beyond just contrast are issues like colour blindness...
        - Normal vision should read the number 29.
        - Red-green deficiencies should read the number 70.
        - Total colour blindness should not read any numeral.



    - Use of graphics element:
        - Vector vs Raster.
        - Simple illustrations can be made in Powerpoint, and they will look a lot better than scanned ones.
        - A LITTLE animation can be useful in illustrating your point.
- Digital Images
    - Resolution
        - You can get low resolution images from the web.
        - Right mouse click on a pc to save an image.
        - 'Print Screen' button captures screen image to clipboard.
        - Free screen capture programs like Screenhunter.
        - Scanners for:
            - Slides.
            - Print images.
        - Scans from books may create 'checkerboard' pattern.
            - Can be removed by 'descreening'.
        - Use pictures that are a good resolution for the media you are using.
        - Useful generalisations:
            - Scanning a print for a poster:
                - same size = 300 dpi
                - much bigger 600 dpi
            - Scanning a slide for a poster:
                - minimum 600 dpi.
                - check optical capacity of your scanner (1200+?).
        - Digital Camera Images:
            - 3 megapixels gives you a quality A4 print (300 dpi).
            - 1.2 megapixel image will give you a good print at normal photo size.
        - Illustrations:

        - Can be very effective when well designed and explained.
        - Don’t obscure the words!
        - Can dictate a colour scheme that compliments your photos and graphics.
    - Sources and Credits:
        - Always give credit where credit is due.
- Practice and time yourself
- Try the equipment before the day
- Make cheap black and white transparencies as a backup.

8. Evaluation

There should be an annual research progress presentation, but currently you are required to give one seminar presentation prior to final evaluation. A committee of stuff members will evaluate your research work based on the following criteria. If any of the criteria are judged to be below average, the entire effort is subject to rejection until improvements are made. (Please provide the evaluation form as a soft copy in the pack).

Literature Review
The research report should contain an extensive literature review related to your topic. The committee must be convinced that you thoroughly understand the topic and have spent enough time researching the topic.

Writing Style
Technical writing skills are critical to a computer science professional. Your final report should be suitable for publication in a computer science journal or proceedings.

Oral Presentation
Oral communication skills are important for any professional. Your presentations for the proposal and final report should be well rehearsed and presented in a professional manner. The committee must be convinced that you are able to respond in an intelligent manner to questions related to your field of expertise.