Research Methods in Computing

(COMP09092)

Lecture 5

Quantitative Research

Quantitative Research

An entire quantitative study usually ends up with **confirmation or disconfirmation of a hypothesis tested**

Researchers using quantitative methods identify **one or a few variables** that they intend to use in their research and proceed with data collection related to those variables

Quantitative Research

Quantitative data means **data or evidence based on numbers**

Within computing, the objective is to develop and employ models based on **mathematical approach, hypotheses and theories** pertaining to some computing related phenomenon

Quantitative data is the main type of data generated by **experiments and surveys**

Questionnaires and Surveys

The idea of a survey is to obtain data from a large group of people or events in a **standardised and systematic way** in order to look for **patterns of data that you can generalise**

A common use of a survey in computing is in **user evaluation of software or prototype**

Questionnaires and Surveys

A **questionnaire** is a specific instrument that can be used for data collection within surveys

For example, you could also use structured interviews as part of a survey

Questionnaires and Surveys

Not an easy job to design a good questionnaire or survey

Expect to have to **iterate quite a few times**

Think about running a **small pilot study** in which you test robustness of questions

Might be that some questions **don’t make sense or ramble on**

Questionnaires and Surveys

Need to decide what data you wish to generate

The data could be directly associated with your research question(s)

Also need to think about how you might analyse your data, patterns you might look for and interpretations that might arise for which you will need additional data

Questionnaires and Surveys

Best used with current topics where **people are happy/eager/interested to contribute** and where they have already well informed opinions

Think carefully about **target audience** – don't just 'fire off' questionnaires

Direct questionnaires to **named individual(s)**

Questionnaires and Surveys

The nature of questionnaires and surveys are that you are trying to generate **a lot of responses**

Means that you need to spend a lot of time:

- **Identifying suitable recipients** (their email addresses)

- **Chasing them up** to make sure they reply

Questionnaires and Surveys

Various sources state that a response rate of anything between **20-30% is quite good from a random survey**

In order to get enough replies to make some meaningful statistical analysis need to **send out a lot of questionnaires/surveys**

Questionnaires and Surveys

Need to think about **where the questions will come from**

Are they from previous study/issues identified from your **literature review?**

Why these questions? How to they relate to your research?

Who are you going to ask and why these people?

How many people? Are they representative of different groups?

Questionnaires and Surveys

In terms of sampling - need to ensure sample is **small enough to manage in terms of time constraints** but large enough to generalise

Also sample must be **representative** of the population relevant to your study

This will affect the reliability of your results and **how you discuss your conclusions and recommendations**

Questionnaires and Surveys

Need to think about **bias in the way we word our questions**

Use of **'loaded questions'** can bias the results in participants being guided by the questions

Also **who you get to complete your forms** can cause the study to be biased – i.e. using fellow students (unless your project involves students), friends and family!

Questionnaires and Surveys

Make sure the questionnaire has **an introduction** section or covering letter that explains the **purpose of the study and why they have been selected to complete it**

Take care with questionnaire **structure** and **order of questions** – be systematic and logical

Make layout attractive – be **consistent and clear**

Questionnaires and Surveys

Avoid **unanswerable questions** or ones lack relevance and purpose - The pilot study should help identify these

Keep questionnaire short and to the point – around **2-4 pages**

If questionnaire is online then **check that the links work**

Questionnaires and Surveys

Think about the types of questions you might ask, for example:

- **Closed** (yes/no)
- **Multiple-choice** (several options to chose from)
- **Scaled questions** (Likert scale from 1-10 or 1-4)
- **Open** (respondent supplies own answer)
- **Matrix questions** (identical response categories assigned to multiple questions)

Questionnaires and Surveys

Next slide shows part of an actual questionnaire on how students use games for learning

Note the use of matrix, open and multiple choice questions

Also note at the top of the page it states what the purpose of the questionnaire is

File Edit View Favorites Tools Help

Questionnaire for the Identification of the Main Motivations for Playing Computer Games Current

The purpose of this questionnaire is to assess and identify the main motivations for playing computer games and also to assess the applicability of these motivations to Higher Education. We would be grateful if you could complete this survey as the research could have an affect on how we learn in the future and will hopefully make the learning process more interesting for us all.

16. If you had the opportunity to use computer games for learning in your programme at University, how would you rate each of the following reasons in terms of importance in learning?

	Very Important	Important	Neutral	Un-Important	Very Un-Important	Don't Know
Playing games provides me with a challenge.						
Playing games allows me to compete.						
Playing games allows me to cooperate.						
Playing games gives me a feeling of recognition.						
Playing games gives me a sense of control.						
Playing games allows me to enter a fantasy world.						
Playing games stimulates my curiosity.						
Playing games helps me to fill in my leisure time.						
Playing games gives me pleasure.						
Playing games helps me to relax.						

17. Please list any computer games you have used to learn in Higher Education along with the name of the module it was used in.

18. Do you believe that computer games can be used to learn in a Higher Education environment? Please give reasons for your answer.

19. What types of skills do you think can be obtained from computer games that would be relevant to Higher Education?

- Problem solving
- Reflection
- Analysing/classifying
- Collaboration/teamwork
- Leading/motivating

Done Internet 100%

start SurveyMonkey - Que... [SURVEY PREVIEW M... 10:13

Questionnaires and Surveys

Show through the questions asked you have a **good background knowledge** in the area

Take care over issues of **confidentiality** or security – do you need to know the respondent’s name/position?

Most questionnaires are **best supported by interviews** – can ask question whether they would be prepared to take part in follow-up interview

Questionnaires and Surveys

In terms of processing your results search out **as many correlations between questions as possible**

This will bring **rich and interesting insights** into your work

For example, you might find that those who agree strongly with one statement also tend to agree with another, or

Agreement with one statement correlates closely with disagreement with another

Questionnaires and Surveys

You can develop a **paper-based survey** (can be quick and effective) and get people to complete it while you are present

You can use some **online survey software** such as:

- SurveyMonkey (www.surveymonkey.com)
- Zoomerang (www.zoomerang.com)

Experiments

In academic research, an experiment is a strategy that investigates **cause and effect relationships**

An experiment is used to **prove or disprove an hypothesis**

For example, could be related to a network design, simulation and test of different network approaches or configurations to see which is provides quicker data transfer

Experiments

When designing an experiment need to think about the **hypothesis to be tested**, the **variables to be controlled and measured**, and **internal and external validity**

Experiments

An experiment is based on a hypothesis to be tested

A hypothesis is a **statement that has to be tested through devising a test** that will provide clear evidence to support it or reject it

For example:

- When factor A occurs B will happen
- An increase in D causes a decrease in C

Experiments

The experiment strategy involves **making measurements of the dependent variables and observing change**

Typical things that are observed and measured include:

- **Self-report responses** (e.g. the subjects of the experiment complete a questionnaire about their feelings or how that rate a concept)

Experiments

- **Behavioural counts**: the number of times a certain kind of behaviour occurs
- **Number of bugs** in a piece of code
- **Time to process** certain data

There should be a **‘before’ and ‘after’ measurement** (called **pre-test** and **post-test**)

For example, end user views before and after the introduction of a new system to see if any change is detected

Experiments

Independent and **dependent variables**:

Independent variables are **manipulated by the researcher** and affect one or more dependent variables

An experiment will be based on manipulation of the independent variable to **observe changes in the dependent variable(s)**

Experiments

Independent variable is the **cause**

Dependent variable is the **effect**

For example, a new teaching approach via a computer game or app to improve exam results in programming modules could be investigated via an experiment

Experiments

Independent variable is the **new approach** (game or app) and the dependent variable is the **exam results**

Independent variable is **controlled by the researcher** (features, functions of the game or app)

Dependent variable **changes as a result of changes to the independent variable** (exam results)

Experiments

Normally quantitative data is used because need to **measure change and use statistical analysis**

Important to decide before carrying out experiment exactly **what will be measured and what statistical tests you will use on the results**

Your experiment has good external validity if your results are not unique to a particular set of circumstances – but are **generalisable**

Experiments

Quasi- or field experiments:

Quasi means ‘as if’ and try to remain true to the spirit of classic laboratory experiments

…but concentrate on observing events in a **real-life setting** where there is a ‘naturally occurring’ experiment

Experiments

- **Static group comparison –** Participants are divided into **two groups**. Researchers apply the treatment to one group and do nothing to the other group. The performance of both groups is then measured. Differences in outcome between the groups could be explained by the treatment

Experiments

- **Pre-test/post-test control group –** Participants are randomly assigned to one of two groups. Performance is measured before intervention. Treatment is given to one group. Performance of both groups is then measured. Any difference is assumed to be caused by the treatment

Any experimental design has its merits and its limitations

Experiments

Possible experimental designs:

- **One group, pre-test and post-test** – participants performance is measured e.g. using old way of doing something), the researcher then applies the treatment (e.g. new way of doing something). They then measure the participants' performance again. By comparing the before and after scores, the researchers can asses the effects of the treatment

Recording Findings

Simplest method is to use a **spreadsheet or database**

Responses can be **coded** to allow entry into the spreadsheet / database

Excel works best on **numerical data** giving far more scope for complex calculations

Access works best with **alpha or alphanumeric data**, since it can cope with reasonable amounts of text

Analysing Findings

It is particularly important to refer back **to the original aims of your study and the hypotheses that you wish to test at this stage**

It is important to keep your **analysis focused**

Analysing Findings

Descriptive Analysis

Describes the distribution and range of responses to each variable and examine the data for skewness

Top line data

How many respondents answered a certain question in a certain way

Analysing Findings

More detailed analyses:

Bivariate Analyses

Gives more detail about particular **sub-groups and sub-categories**

Use simple cross-tabulations to **identify trends and examine possible associations** between one variable and another

Responses are analysed by reference to **particular groups** (e.g. by age etc)

Analysing Findings

Multivariate Analyses / Regression Analysis

Looks at a **wide range of variables, helping to bring out trends and relationships**

Can be used to test the **effect of one variable on an outcome**, whilst controlling for another

When analysing results, **care must me taken that trends and relationships are not coincidental**

Analysing Findings

Main statistical methods for analysis:

Frequency (50 men, 50 women): Number of responses from raw data

Proportions (0.5 men, 0.5 women): Frequency figure divided by frequency total

Percentages (50% men, 50% women): Proportion multiplied by 100, useful for measuring rates of change

Ratios (men to women 1:1): Divide 1st figure by itself (=1) and 2nd figure by 1st (in this case also 1)

Analysing Findings

Calculating the average: Note the different ways of expressing an ‘average’

Mode – Most frequently occurring answer, highlights the largest ‘modal’ group

Median – Middle value from the data range, the point halfway between the two central values

Mean – Total sum of answers divided by the number of answers (easily distorted by an occasional high value)

Analysing Findings

Data can be analysed using both Excel and Access

Excel creates charts and calculates the mode, median and mean

Access isolates particular queries from the set of data

Analysing Findings

Visual aids for quantitative data analysis include:

- Tables
- Bar charts
- Pie charts
- Scatter graph
- Line graphs

Analysing Findings

Finding relationships in the data:

You might want to see if there is an association or relationship between **the values of one variable and another, or between one data set and another**

Analysing Findings

Some statistical tests to explore relationships include:

- Correlation coefficients
- The null hypothesis and tests of significance
- Chi-square test
- T-tests

These are quite advanced tests that you would need to learn if undertaking a project with significant data sets and statistical analysis

A useful resource full of information about designing, writing and using questionnaires is the Audience Dialogue website

www.audiencedialogue.net

References

Oates, B.J. (2006) Researching Information Systems and Computing. London: Sage