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How to set about a research project

P. CLEATON-JONES

Sooner or later, through natural curiosity or academic need, students or graduates will undertake research. A natural apprehension often accompanies this venture into the unknown but is unnecessary since research is a discipline with basic rules, as is the rest of science.

What is known as the scientific method is the basis for research. This method consists of six logical steps (Table I) which should be used. The problem to be investigated must first of all be defined, not always an easy task. This should be followed by an evaluation of existing information on the problem, which information will be found in scientific articles and books. Organization and evaluation of this information must follow, after which the hypothesis to be tested can be formulated. A method of testing the hypothesis is then devised and applied, experimental results are analysed and finally conclusions are drawn. Whether research is simple or complex these steps apply.

Those undertaking research for the first time may think that the steps in the scientific method are too simple but as their experience increases they will appreciate the logic involved.

Research protocol

Once the first three steps in the scientific method have been completed, it is time to devise a research protocol. This is a plan of attack. Inherent in the plan are several points, highlighted by Calnan:[1] the problem should be of personal interest to you; it should require investigation; a solution should contribute to knowledge; it should be capable of being solved.

A protocol layout which has been found to be convenient is that used in the Faculty of Dentistry at the University of the Witwatersrand (Table II). If new researchers work systematically through using this layout, they will find it possible to produce a reasonable protocol for discussion with more experienced researchers. The first three headings listed are self-explanatory and the advantage of outlining experimental procedure should be obvious, but the layout also contains three important points often neglected by the inexperienced. They concern statistical planning before a project is begun and an estimation of cost — of both money and time. These will be considered later in this paper.

TABLE I. STEPS IN THE SCIENTIFIC METHOD

- Recognize and define the problem
- Gather and organize information on the problem
- Construct a hypothesis
- Test the hypothesis
- Analyse the results
- Draw conclusions

TABLE II. PROTOCOL LAYOUT

- Title of project
- Summary of background information
- Statement of research objective
- Experimental procedure
  - Model system
  - Experimental design and methodology
  - Assignment of tasks
- Statistical analysis
- Budget
- Time schedule

TABLE III. SUGGESTION FOR A RESEARCH ROUTE

- Discuss your ideas with someone
- Formulate a research protocol
- Discuss the protocol with a statistician
- Estimate the resources needed
- Get the approval of your departmental head
- Consider the need for approval by ethical committees
- Get the necessary resources
- Do a pilot study
- Reassess the protocol
- Do the definitive investigation

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Research route

Now that the reader has an understanding of steps in the scientific method and the layout of a protocol, it is time to consider a practical research route (Table III). The route has proved to be successful when used by postgraduate students in the Dental Research Institute.

Consider the steps outlined. The need to discuss ideas with someone, a colleague, friend or family member, cannot be stressed strongly enough. Indeed, the more critical the person is, the better. A clearer idea of how to proceed should emerge from the discussion. Once the research has been approved in principle by the departmental head, consider very carefully the need to obtain approval from an ethical committee dealing with research on man or laboratory animals. Ethical standards in research are constantly changing and it is important that new researchers establish their credibility in this field. Professor Burchell and Dr De Klerk will deal with ethical concepts in other articles in this issue.

What do I want to do?

In order to do research a spark is needed to ignite thought processes. While writer's block may prevent prose being put down on paper, it is easy to throw up one's hands and say, 'I don't know what to study'. A good starting point for the young researcher is to consider a clinical problem or physiological phenomenon that has always intrigued him and which is within the ambit of interest of the department in which he works. Having done that and having looked at review articles dealing with the matter, the problem must be clearly defined. This means breaking the idea down into its component parts and writing down on paper exactly what must be investigated. In doing this it is important to concentrate on departmental strengths whether intellectual or physical, for example, in the form of equipment. It is much easier to build on existing knowledge in a department than to try and open up a whole new research avenue which will cost a great deal of time and money.

The research supervisor must be chosen very carefully indeed. It is not wise to choose one's supervisor on purely political grounds, that is, the head of department or an influential person whom you feel will help your career. It is much better to work under a person, whoever he or she may be, who is stimulating and skilled in analysing other peoples' research. Some individuals who have a reputation for good research work are loners who concentrate solely on themselves. Those people should be avoided. Also make sure that your supervisor will have time to spend with you. No matter how good he may be, if he does not have time to help you it is better to choose somebody else. Remember to meet your supervisor regularly and to explain what progress you have made. Also, be prepared to accept criticism from your supervisor who will be criticizing not you as a person but the work being done.

Do aim to publish your findings. Our mandate as researchers is to add to knowledge. We are in some ways parasites on society in that we exist sponsored by research grants paid by our fellow members of the public. We have an obligation to share with them our knowledge and it is not good enough merely to present this knowledge in verbal form through lectures or deliveries at scientific gatherings. We must aim to publish the findings to enable others to build on our observations. The higher the standards of the journal chosen and the more critical that journal's referees are, the more one will grow.

Grantsmanship

All research projects cost money, some more than others. By concentrating on departmental strengths it is often possible to cut costs. An important question for the new researcher to ask early on is, 'What expertise is needed to do the research that I wish to undertake, and that facilities are available?' A good maxim to remember is that people are more important than things. If one is able to get on with people it is often easy to use equipment in other departments or institutions, thus preventing duplication of expenditure. An important facet of this planning is not to undertake too complicated a research project in the beginning, unless one is linked to a more established and experienced researcher. To start off slowly, gain confidence, and then build up is a fair method of approach.

As one starts research one begins to build up scientific credibility. This credibility is most important for long-term research funding and acceptance by the international scientific community. Funding for research may be from your university, your employer, for example, a hospital service, or from one of the statutory bodies such as the Medical Research Council. Most adopt the approach that an application must be made by a specified closing date on standardized forms. These forms vary from institution to institution but in general require an outline of the project, the methods to be used and then a detailed breakdown of financial needs. It is not good enough to be vague here, for example, 'running expenses — R6 000'. One must be specific and itemize needs because granting bodies do not have adequate funds to provide everything. They must try to assess whether the researcher has a good grasp of costing and, if money is short, how much can be given to the individual to initiate the research even if the ideal amount is not available.

Two approaches may be adopted here. Some applicants work out how much money they require then multiply it 2 or 3 times on the assumption that their budget will be cut anyway and if it is they will end up with more or less what they want. This is a bad approach to follow because it can be easily detected by skilled researchers on grant committees, who will then ultimately disregard future applications and award negligible amounts. This outcome is rather like that in the story of the little boy who cried wolf. I believe a better approach is to be realistic, to develop a reputation for asking only what one needs, and then to deliver the goods in the form of published articles to show that the money has been well spent before asking for

the next grant. It is a good policy to attach oneself to somebody with a research record whose reputation will aid in obtaining the first grant.

Inherent in grantsmanship is the budgeting of time. Thus the two questions when planning research are: how much time do I have and what will the research cost? One will have to budget within one's means for both time and money and if necessary the project may have to be whittled down accordingly.

Record keeping

An absolutely vital component of research is the keeping of good records. Many approaches have been used but in general one may summarize them as the use of laboratory books or files. Some people keep clearly labelled hard cover notebooks into which are written every aspect of the research under way, and which are kept in a safe place. Others use filing systems of one or other type into which all notes, records and results are placed for safe keeping. There are several reasons for this good record keeping. One is, obviously, for later analysis of data. But recently the increase in scientific fraud has made it necessary for researchers to justify their findings and conclusions by producing original data for scrutiny by independent persons. In the absence of records one's reputation is at stake.

Bias

Bias is difficult to define and it is something inherent in all researchers, no matter how honest. Bias may be deliberate or unintentional and implies a subconscious or conscious influencing of the research result through choice of experimental method, subjects and so on. In other words bias means anything that would tend to influence the experiment in a way that experimental conditions would not. Poor choice of subjects through the lack of random sampling is a good example of bias.

It is important to always use control groups, sham operations or placebos to ensure that findings are due to experimental procedures and not merely to natural variation. Bias can never be entirely avoided but should be reduced as much as possible; the first step is for researchers to examine each protocol for possibilities for bias.

Final points

Obviously, in a short article such as this only some guidelines can be given, aimed in this instance at the new researcher. For more complete advice Calnan's excellent books[1,2] are recommended.

Two final points must be mentioned. The first is tenacity. Research consists of about 5% excitement and 95% tedium. Many can cope with the excitement but few have the tenacity to persevere through the tedious business of fund raising, data collection, and so on. Unless one develops tenacity, success will never be achieved.

The final point concerns authorship of the eventual scientific article. More friends are lost, co-operation ruined and even enemies made through authorship of articles than anything else in science. Public recognition for research done is often a researcher's only reward and if he does not receive it he will be angry and frustrated. Decide during the protocol planning stage who are to be co-authors and in what order their names will appear on any subsequent articles. This will avoid much misunderstanding and will increase one's credibility as a researcher.

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