



Experimental Research Method

Abstract:

This chapter explains the meaning of experimental research. It describes the steps in experimental research. It particularly explains meaning of dependent and independent variables. Concept of extraneous variable and law of single variable are also explained. Importance of internal and external validity is highlighted. The chapter also explains various types of experimental research.

Keywords:

Steps in experimental research, randomization, experimental and controlled group, law of single variable, dependent and independent variables, types of experimental research

INTRODUCTION

Descriptive, historical and experimental are the main methods of research. Research in librarianship can be conducted by applying descriptive (survey, case study) and historical methods. Experimental research method is primarily used in natural sciences. However, to some extent it is used in social science disciplines. Library science is also a social science. Therefore like other social sciences, it is possible to use the experimental research method in librarianship also. Compared with the other research methods, results of experimental research method are more reliable as it can have more control over its variables and the research environment. Experimental research method is particularly useful in finding cause and effect relationships between variables. Experimental research method is more useful to find answers to questions such as, what causes a specific result; what are the reasons for an effect; what are the elements responsible for a specific response, which specific element is causing specific behaviour etc. Thus experimental research method is useful in understanding the variables responsible for a specific effect. In spite of its better reliability and usefulness, the experimental method is not much used in librarianship. It is used only in eight to ten percent LIS research (Powell and Connaway, 2004).

Examples of application of experimental research in librarianship date back to 1960. In 1960 Cyril Cleverdon, (Cleverdon, 1960), the then Librarian of Aeronautical Research Laboratory, Cranfield (UK) applied experimental research to study the relative efficiency of various indexing systems. Cleverdon conducted two experiments for studying the efficiency of indexing systems. These two experiments are known as Cranfield 1 and Cranfield 2. Both these are the early examples of application of experimental research in librarianship. Donald Urquhart was Director of the British Library Document Supply Centre (BLDSC) in 1970s and 1980. He conducted number of informal experiments at this centre. Based on his experience and experiments at BLDSC he wrote a book entitled, 'The principles of librarianship'. In this book he has explained 18 principles of librarianship. One of these principles is enunciated as 'library science is an experimental science' (Urquhart, 1981). This further confirms that experimental research method can be adopted in LIS research. In recent years, the Text REtrieval Conference i.e. TREC (trec.nist.gov/) conducts a considerable experimental research

in information retrieval. The discussions below will help you understand the nature, process, and features of experimental research method.

WHAT IS EXPERIMENTAL RESEARCH?

A research conducted to know whether a specific change is resulted due to a specific cause is known as experimental research. An experimental research is conducted to test the hypothesis that a specific effect in 'A' is caused due to 'B'. Of these two variables 'A' is called dependent variable and 'B' is called independent variable. The dependent variable depends on other variable for change in itself; therefore it is called 'dependent variable'. In experimental research an independent variable is applied to dependent variable to test whether the change predicted by the hypothesis is caused or not. In short, the research investigating cause and effect relationship between variables is known as experimental research. Experimental research intends to know whether a specific manipulation or treatment causes the expected change in the dependent variable or not. Experimental research does not intend to find the reasons responsible for the happening in the past. Historical research, however, is intended to know the causes for an event happened in the past. Experimental research applies an independent variable to a dependent variable and tests the effect of independent variable on the dependent variable. This is the research method which actually conducts an experiment to verify the cause-effect relationship between variables.

STEPS IN EXPERIMENTAL RESEARCH

1. **Identification of problem:** Experimental research is useful in investigating cause and effect relationship between variables. Considering this feature of experimental research, the researcher should select a research problem which intends to find cause and effect relationship between variables. The research problem should enable to apply the independent variable to the dependent variable. Also the research problem identified should enable to control the research environment. Given below are some examples of research problems suitable for experimental research.

- (a) An enquiry into the relationship between user education and the user's efficiency of searching databases
- (b) A study of correlation between easy availability of reading

- (c) material extent of its use by children
- (d) Does availability of literature affects citation?
- (e) Are method used for arranging reading material and its use correlated?
- (f) Does advertisement of libraries has any impact on their extent of use?
- (g) Is there any relationship between reading advice and quality of leisure reading?

2. Formulating hypotheses: Main purpose of experimental research is to verify cause and effect relationship between variables. Basic assumption of experimental research is that, 'any change in a given variable is a result of some cause'. Experimental research is conducted to find the cause behind an effect. Therefore, an experimental researcher formulates a 'causal hypothesis'. A causal hypothesis is a hypothesis which predicts that a specific effect is resulted due to a specific cause. Such a hypothesis also called as research hypothesis. Hypothesis is tested by analyzing the collected data. A meaningful hypothesis for the problem identified in the first example given in step number one could be: 'User education considerably increases student's database search efficiency'. Establishment of cause and effect relationship is the prime purpose of experimental research. Therefore hypothesis is must for an experimental research.

3. Selecting variables for experiment: In this step of experimental research the researcher selects elements for research. These are elements on which experiment is to be conducted. These are also called as variables. Objectives of the concerned research help in selecting variables for experiments. For example, by verifying the hypothesis 'user education considerably increases student's database search efficiency' the researcher wants to know whether user education is the main cause that increases student's database searching efficiency. In other words the researcher want to know whether there is any relationship between (a) user education and (b) student's database search efficiency. Experimental research will enable to test such hypotheses. For experimental research the researcher has to select appropriate dependent and independent variables. For the research problem mentioned in the above example, student's database search efficiency and user education will be the two variables. Of these two student's database search

efficiency will be the dependent variable and the user education will be the independent variable. For experimental research the researcher has to select the dependent variables /elements having exactly the same characteristics. In other words, the elements (i.e. the dependent variables) to be selected for experiment must possess same characteristics; they should be similar in nature. For example, if the researcher intends to select 50 students for the said experiment of user education, then these 50 students should have the same characteristics. That is they should be residents of the same geographical area, they should be of the same age, they should be studying the same subject, they should belong to same academic level, and they should be studying in the same language. For example,

Area- Rural area

Age - 22 years

Subject - Economics

Academic year - M. A. 1st year

Language of study - English

At this stage the experimental researcher has also to select independent variable for research. Selection of dependent and independent variable depends of the nature of research problem, objectives, and hypotheses of the given experiment.

4. **Randomization:** The process of randomly dividing the dependent variables into two equal groups is known as randomization. Randomization applies random sampling method to divide the elements in groups. Dividing the 50 M.A. Economics students (mentioned in the above example) into two groups randomly will be called as randomization. In the experimental research terminology the two resultant groups of randomization are known as 'experimental group' and 'controlled group'.

EXPERIMENTAL AND CONTROLLED GROUPS

As mentioned above the elements in the dependent variable are divided into two groups through randomization. One of these groups is known as 'experimental group' and the other is known as 'controlled group'. The group on which experiment is to be performed is known as experimental group. Independent variable is applied to experimental group and effects of its application are observed. Controlled group is the group on which no experiment is conducted. The controlled group is used only for the comparison purpose.

Randomization increases the external validity of the experiment. External validity means the ability to generalize. Thus randomization increases the possibility of generalization. Randomization also increases internal validity of the experiment. Internal validity means reliability of research. Results of experimental research will not be reliable unless it applies randomization.

5. Application independent variable: In experimental research two types of variables are taken into consideration. As mentioned above, one is known as independent variable and the other is known as dependent variable. The variable which depends on the other variable for change in itself is known as 'dependent variable'. It is called dependent variable, because it depends on other variable for change in itself. As against this, the variable which affects the dependent variable; which is responsible for change in dependent variable, is known as 'independent variable'. Independent variable does not depend on any other variable, for change therefore; it is called as independent variable. The independent variable is also called as 'experimental factor' because the experiment is conducted by applying the independent variable to the dependent variable. 'Causal factor' is another name for the independent variable. It is called as causal factor because this variable is responsible for bringing change in the dependent variable. In the example mentioned above 'database search efficiency' is dependent variable and 'user education' is independent variable. This is because as per the hypothesis of this example, database search efficiency depends on user education. In this example, user education can also be referred to as causal factor because it is causing change in the student's database search efficiency.

In experimental research, independent variable is applied to dependent variable after formulation of hypothesis and after preparing control and experimental groups through randomization. This process of application of independent variable to the dependent variable is also known as 'administering the treatment'. In the case of our above example the 50 M.A. Economics students will be first divided into two equal groups known as experimental and controlled group. Each group will have 25 students. User education will be provided to the experimental group. Thus independent variable (i.e. user education) will be applied to dependent variable (i.e. selected students of M.A. Economics). The process of application of

independent variable to the dependent variable is known as manipulation. It is also called intervention.

LAW OF SINGLE VARIABLE

Through the above example we learnt that experimental research can be conducted to know the effect of user education on student's database search efficiency. In this example only one independent variable (user education) is applied and conclusions are derived by measuring its effect on dependent variable. That means only one variable is applied at a time. For ensuring that the resultant effect in the dependent variable is caused only due to the specific independent variable it is necessary to apply only one variable at a time. Suppose, in the above example, along with user education the students were also provided with search manuals and then the students were asked to search information from the databases. Further suppose that the students were now able to search the databases efficiently. The researcher will not be able to conclude whether the students were able to search databases efficiently due to the user education or due to the availability of the search manuals. Therefore to ensure that the change in the dependent variable is caused only due to a specific independent variable it is essential to apply only one independent variable at a time. This practice applying only one independent variable at a time is known as law of single variable.

INTERNAL AND EXTERNAL VALIDITY

The act of scientifically proving the effect of independent variable on the dependent variable is known as internal validity. In other words it is ensuring that the change in the dependent variable is caused only due to the application of a specific independent variable. There is a direct relation between the extraneous (external) variable and internal validity i.e. more the control over extraneous variable; more the internal validity. It is also observed that more the internal validity more the reliability of the research results. Unexpected happening during pre and posttest, experimenter's biasness, maturation of the experimental elements, etc. adversely affects the internal validity. Internal validity decreases due to these factors. Internal validity can be increased by proper control over these factors during experiment.

EXTRANEous VARIABLES

There could be many independent variables useful for a given experimental research. An independent variable which is not chosen as a treatment for specific experiment, which however can affect the dependent variable is known as 'extraneous variable'. As per the law of single variable only one independent variable is applied at a time to the dependent variable. In spite of this an extraneous variable may affect the dependent variable. Thus, forced, unexpected intervention of the extraneous variable could change the research results. To ensure that the change (effect) in the dependent variable is caused only due to the specific independent variable applied by the researcher, the extraneous variables have to be controlled. Controlling extraneous variables means ensuring that no extraneous variable is affecting any of the groups in the experiment.

Internal validity of the experiment can be increased by ensuring that the change in the dependent variable is caused only due to the applied independent variable. For increasing internal validity of the experiment it is necessary to control the extraneous variables. Extraneous variables can be controlled with the help of following strategies.

1. Treating both the groups (control and experimental groups) equally
2. Applying the independent variable for sufficient time
3. Precise measurement of effect of independent variable

Generalization ability of the experiment is known as external validity. An experiment, whose results are applicable across space and time, is said to have external validity.

6. Comparison of controlled and experimental groups: From the above five steps in the experimental research you must have noticed that during the experiment an independent variable is applied only to the experimental group. Independent variable is not applied to the controlled group. After experiment i.e. after applying the independent variable to the experimental group, both the groups are compared so as to test the effect of the independent variable. For example, the researcher conducting the experiment discussed in the example above i.e. the user education and database search efficiency will, after experiment, ask students in both the groups to search information, say for example, from Ebsco database. Presume that he has asked students in both the groups to search information on

'agricultural prices'. The environment is controlled. It is controlled by allowing them to search information only from Ebsco database; all the students are given equal time (say one hour) to search the information; and they are also informed where from to take the vocabulary required for searching the information. Controlled environment is an essential feature of experimental research. Controlled environment increases internal as well as external validity of the experiment. Students in both the groups will be asked to search information in such a controlled environment. The researcher will be observing the experiment carefully and will be recording his observations. Based on the observation he will compare both the groups. About the above experiment it will be useful to record the following observations.

- (a) Terms used for searching by students in both the groups
- (b) Where from they got the terms (thesaurus, classification scheme, their own knowledge, etc.)?
- (c) Recall percentage
- (d) Precision or relevancy percentage
- (e) Time taken to search the information

You must be remembering that only one group (i.e. the experimental group) is imparted user education. However, for testing the effect the researcher has asked both the groups to search the information. After both the groups finish their search, their results will be compared at this stage of the experiment. In more general terms at this stage of the experimental research the researcher compares both the groups i.e. the controlled group and experimental group. If the comparison shows that the students in the experimental groups have searched information more efficiently than the students in the controlled group then the hypothesis 'user education considerably increases student's database search efficiency' will be proved and therefore the hypothesis has to be accepted. Such a result will prove that the two variables i.e. user education and database search efficiency are related. In other words it will prove the cause (user education) and effect (database search efficiency) relationship. As against this if the comparison shows that the students in both the groups have searched similar information; have similar database search efficiency, then it has to be concluded that there is no correlation between the two variables in the experiment. In such a case the hypothesis 'user education considerably increases student's database search efficiency' will be disproved and it has to be rejected.

7. **Report writing**
Like any other research, the experimental research too is concluded by writing report of the experiment conducted. Detailed recording of the methodology is the special feature of report of experimental research. In report, the experimental researcher gives minute details of the material used, processes, and procedures adopted; methods used to control the environment, etc. Reliability of experiment is verified by replication (repetition). To enable replication, to enable verification, the experimental researcher should provide minute details of the experiment in the report.

TYPES OF EXPERIMENTAL RESEARCH

There are various types of experimental research. These types are created on the basis of number of groups in the experiment and the time when the tests (comparisons) are conducted. Single group experimental research and two groups experimental research are the two main types of experimental research.

1. Single-group experimental research

As its name suggests this type of experimental research consists of only one group. It has only experimental group. It does not have controlled group. There is only one group in the experiment, therefore it is known as single group experimental research. In single group experimental research only one group is used therefore there is no need to divide the research elements into two groups. Since no group is to be divided, this type of experimental research does not adopt randomization. In single group experimental research, the group is tested with the research objective before the application of experimental factor (i.e. before the application of independent variable). In our example, the 50 M.A. Economics students will be asked to search information on Agricultural prices from Ebsco database before imparting user education to them. The search results will be observed, measured, and recorded. In other words the researcher will record the number of entries searched, relevancy of the information searched, time taken to search, etc. This process is known as 'pre-testing', as the test is carried out before application of independent variable. After pre-test, the same 50 students will be given user education. After user education, again the same 50 students will be asked to search information on the same topic and from the same database used in the pre-test.

Results of this second test will be observed, measured, and recorded. This test is referred to as 'post-test' as it is conducted after the application of the independent variable. If the results of the post-test are found better than the results of pre-test, then it could be concluded that the change in the dependent variable (i.e. user's database search efficiency) is caused only due to the independent variable (i.e. user education). This will prove that there is a correlation between the dependent variable and independent variable. This type of experimental research uses only one group for experiment, and therefore it costs less. Since this type of experimental research uses only one group there is limited impact of the external variable and as a result this experimental research has higher internal validity. However, since this experimental research does not have any group to compare, its external validity is less.

2. Two-groups experimental research

This type of experimental research consists of two groups. These are known as controlled group and experimental group. Validity and reliability of this type of experimental research is higher than other type of experimental research. As this type of experiment consists of controlled group for comparison its validity and reliability is higher. There are two sub-types of two groups experimental research. These sub-types are created on the basis of number of tests conducted during the experiment. The two sub-types of two-group experimental research are:

(a) Two-groups post-test only experimental research

Post-test only experimental research uses randomization. By applying randomization the samples are divided into two identical groups namely controlled and experimental group. Experiment is carried out only on the experimental group. That means the independent variable is applied only to the experimental group. After applying the independent variable, both the groups are tested for knowing the effect of the independent variable. After test if the researcher finds change in the dependent variable then it proves that the independent variable has caused the change. In this type of experimental research there is no pre-test. Therefore, this experimental research method is referred to as 'Quasi experimental method'. However, since this research method does not have pre-test, it is not possible to know the characteristics, condition, and capabilities of the elements

under study. Therefore, one may not be very sure that the change in the experimental group is caused only due to the experimental factor.

- (b) **Two-groups pre and post-test experimental research:**
- In two-groups, pre and post-test experimental research the samples are divided into two groups through randomization. Then both the groups are tested with reference to the research objectives. This is known as pre-test. For example, in the example discussed above, the total 50 M.A. Economics students will be randomly divided (randomization) into two identical groups, each containing 25 students. Students in both the groups will be asked to search information from the same pre-decided database and on the same pre-decided subject. For example they will be asked to search information on agricultural prices from Ebsco database. Results of their search will be observed, measured, and recorded. This test is known as pre-test. It is called pre-test as it is conducted before applying the independent variable (i.e. before conducting user education programme for the experimental group). After pre-test user education will be imparted to the students in the experimental group. After user education (i.e. after application of independent variable) both the groups will be again tested i.e. they will be asked to search information from the same database on the same topic, under the same experimental environment. The results will be observed, measured, and recorded. This is known as post-test. It is called post-test as it is conducted after the application of independent variable; in our example, after user education. Results of the post-test will be compared with the results of the pre-test. If the comparison shows that the results of the post-test are better than the pre-test, then it could be concluded that the change in the experimental group is caused due to the independent variable. This ultimately, proves the effect of the independent variable (i.e. the causal factor). This classical experimental research consisting pre and post-test is costly, as it needs two groups, and two tests. However, this type of research provides most reliable results.

This type of experimental research adopts randomization. It has pre-test. It also has post-test. Thus this is a complete experimental

research. Therefore, this type of experimental research is referred to as 'true experimental research'. Not only this, but since it adopts randomization, it is also referred to as 'classical experimental research'.

CONCLUSION

Compared with other research method the experimental research method is more reliable research method. Experimental research helps to draw most objective conclusions. It helps to establish cause-effect relationship between variables. In another words it finds causal variables. Knowledge about the causal variable helps in taking managerial decisions. It even helps in controlling the adversely affecting causal variable. Controlled environment is a need of the experimental research. However, it is difficult to control the environment in social science experiments. Library science being a social science, this limitation is applicable to experimental research in library science also. As a result we find very less application of this method in librarianship research in the past. In the recent time, however, it is noticed that this research method is increasingly applied in librarianship. Considering the reliability of this research method, more and more application of this research method in library science research will be beneficial for the development of librarianship.

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