Common Errors Committed by Researchers and Misuse of Statistical Tests in Educational Research

M.A. Yusha’u
PhD, Department of Science and Vocational Education, Faculty of Education and Extension Services, Usmanu Danfodiyo University, Sokoto, P.M.B. 2346, Sokoto, Nigeria

Abstract: The paper discusses common errors committed by researchers and misuse of statistical tests in educational research. It is designed to address questions asked by colleagues, postgraduates and undergraduate students in the faculty of Education and Extension Services. In addressing some of the questions; the paper discussed the meaning of statistics and educational research, explained factors that lead to common errors and misuse of statistical tests (as determinants or determining factors). It also identifies and discussed types of errors committed by educational researchers and how to select correct statistical tests/tools. Finally, the paper suggested that researchers should be careful and critical in selecting design, sample, instrument and statistical tests.

Keywords: Common errors in research, misuse of statistical tests, educational research

I. INTRODUCTION

Many educational researchers are experiencing difficulties when it comes to selecting the appropriate statistical tools for their research in both qualitative and quantitative study. Research involves looking for, collecting and gathering of information through scientific enquiry or other means (Leedy & Ormrod, 2001). In educational research, statistical knowledge plays a vital role, it is a major component of an established quantitative research. The correct use of any statistical tool usually leads to fulfilled and leading conclusion, while the incorrect use of any statistical tool leads to unfulfilled and misleading conclusion (Rajir, Holh, Nizar, Randy & Mohit, 2011). Choosing the correct statistical test in educational research becomes a very challenging task to both lecturers and students of Education (Marius & Vladimir, 2010). Statistics is often perceived by Educationists and Researchers (both lecturers and students) with mixed reaction, as something friendly, unfriendly, difficult, mysterious and hostile (Robert, 2009). A survey conducted by the writer for the purpose of writing this paper from 2011-2016 in the Faculty of Education and Extension Services, Usmanu Danfodiyo University, Sokoto. It is confirmed that a common trend on the statistical tests used by Postgraduate students in conducting research in all the four (4) departments. Common research design, (descriptive, survey,........ methods) and analysis have been preferred by all the departments (i.e. Frequency counts & Simple percentages, Pearson Product Moment Correlation Coefficient, T-test, Chi-Square, ANOVA & Regression Analysis). Other statistical tests like Spearman rho, Mann- Whitney, Friedman, Kruskal- walis, Rash model etc) were rarely used.

However, as some departments are battling with difficulties of choosing the right statistical tests, some units in the faculty have maintained their status quo (given more emphasis to qualitative research methods). Consequently, conflict and confusion set in between postgraduate students and their supervisors regarding the decision on appropriate statistical tool to use.

This paper therefore, is designed to address some of the questions asked often by colleagues, postgraduate and undergraduate students on the right statistical tests to be used in their research studies. Here are sampled plethoras of the questions:

(i) What type of reliability am I suppose to use?
(ii) Am looking for a relationship, what is the right statistical test to be employed?
(iii) What statistics will I use to find a difference between and among variables?
(iv) How can I take a decision?
(v) My Supervisor suggested that I have to use Regression Analysis. What is Regression Analysis?
(vi) I have used t-test but I was told to go and use Chi-square, why? And many questions of similar nature.

In answering the questions the paper discusses: i. The meaning of statistics ii. Factors that lead to misuse of statistical tests iii. Types of Errors committed by researchers in educational research; iv. Selecting the correct statistical tests, v. Suggestions.

Statistics scholars have given hundreds of definitions. Some have defined statistics as statistical data (Plural sense) where as others as statistical methods (Singular sense). Relating to Education it is the quantitative or numerical information found when conducting a research (Gupta, 2013:6).

This definition characterized numerical data as:

(i) Statistics are aggregates of facts.
(ii) Statistics are affected by multiplicity of courses
(iii) Statistics are numerically expressed
(iv) Statistics are enumerated or estimated according to reasonable standard of accuracy.
(v) Statistics are collected in a systematic manner.
(vi) Statistics are collected for a predetermined purpose.
(vii) Statistics should be placed in relation to each other. (Gupta, 2013:6-7).

However as a method, Gupta (2013:9) cited Croxton and Cowden who gave very simple and concise definition of statistics as “a collection, presentation, analysis and interpretation of numerical data.”

This very definition and others given by scholars provided the five (5) stages in a statistical investigation. These are:

(i) Collection
(ii) Organization
(iii) Presentation: Diagrams and Graphs
(iv) Analysis
(v) Interpretation

(Gupta, 2013:9-10).

These served as the bedrock of any educational research.

II. EDUCATIONAL RESEARCH

As to the meaning of Educational Research the American Educational Research Association (AERA) defined Educational Research as “the Scientific field of study that examines education and learning processes and the human attributes, interactions, organizations, and institutions that shape educational outcomes” (AERA, 2016:1).

Based on the presented definitions one can clearly deduce the interplay between statistics and educational research. It is the writer’s belief that to have a presentable research educationally, there is genuine need to select appropriately statistical test that will match the research design, population, sample, instrument and data type. As lack of appropriate and suitable selection may lead to a misuse of statistical tools.

Factors that could lead to Misuses of Statistical Tests: The writer called them the determinants or determining factors of a research:

(i) Design (ii) Population (iii) Sample (iv) Instrument (v) Data

(i) The Research Design

The Research design is the structure of any scientific work that gives the direction and systematizes the research. Different types of research designs have different advantages and disadvantages (Martin, 2008). Choosing a wrong design affects findings and thus leads to unreliable observations, information and results and misuse of statistical tools.

Basically, there are three (3) approaches used to handle research problems which a researcher needs to know. These are:

- Quantitative Research: Requires quantitative analysis
- Qualitative Research: Requires qualitative analysis; and each needs a correct design to follow.
- Mixed methods research: It integrates both qualitative and quantitative research.

Creswell, (2014:32)

Choosing a Research Design

1. Descriptive Designs – observe and describe
   - Descriptive Research
   - Case Study
   - Naturalistic observation
   - Survey

2. Correlational studies – Predict situation and phenomena
   - Case Control Study
   - Observational Study
   - Cohort Study
   - Longitudinal Study
   - Cross Sectional Study
   - Correlational Study in general

3. Semi – Experimental Design – Determine causes and effects
   - Field experiment
   - Quasi – Experimental design
   - Twin Studies

4. Experimental Designs – Determines causes and effects
   - True Experimental Design
   - Double – Blind Experiment

5. Complex Experimental Designs
   - Factorial Design
   - Solomon Four – Group Design
   - Counterbalanced Measures Design
   - Repeated Measures Design
   - Matched Subjects Design
   - Bayesian Probability

(Creswell, 2012)

Next to the design is population, it also plays a vital role in leading to an unreliable result in a research.

(ii) Population in Educational Research

A Research population is generally a large collection of individuals or objects that are the main focus of a scientific query (John, 2016). This gives birth to population sampling and types of sampling.

(iii) Population Sampling

This is the process of taking a subset of objects that are representatives of the entire population. The sample may have
sufficient size to warrant statistical analysis. If the population size is not sufficient, there is that tendency of obtaining an incorrect finding(s) of a research study. Using the correct sampling leads correct choice of a statistical test that leads to a reliable finding(s).

Types of Sampling

- **Non probability sampling** include: Convenience sampling (subjects are easily accessible); Consecutive sampling (a technique in which every subject meeting the inclusion criteria is selected); Quota sampling (Non randomize use to represent geographical or community); Judgemental/Purposive sampling (purpose selection based on judgment on a typical sampling); Snowball sampling - Is a non-probability sampling technique that is used by researchers to identify potential subjects in studies where subjects are hard to locate. It works like chain referral common in Sociology and statistics researches (John, 2016 & Creswell, 2012). Here members of the population do not have equal chance of being selected.
  - It is useful for Pilot studies, Case studies, Qualitative research and for hypothesis development.
  - This sampling method is usually employed in studies that are not interested in the parameters of the entire population (John, 2016 & Creswell, 2012).

- **Probability Sampling** Include: Simple random sampling (each subject in the population has an equal chance of being selected) (Del, nd:1); Systematic sampling (selection of every n\textsuperscript{th} (i.e. 5\textsuperscript{th} & 10\textsuperscript{th}) subject in the population).

**Stratified sampling** (A representative number of subjects from various sub-groups).

**Cluster sampling** - Cluster samples chosen from pre-existing groups.
- Guaranteed completed randomization and non biasness
- It provides accuracy of the statistical methods after experiments.
  
  (John, 2016

(iv) **Research Instrument**
A generic term researchers use for a measurement device (survey, test, questionnaire, etc). There are basically 3 types of research instruments used in educational research, and these are: (i) Researcher’s designed instrument (ii) Adapted instrument, or (iii) Adopted instrument

**Instrument** is the device and instrumentation is the course of action i.e. the process of selecting, developing, testing and using the devices (Denzin & Lincoln, 2015).

![Fig 1: Categorization of Research Instrument.](image)

**Instruments:**
- Categorized into 2
- (i) Researcher completed instruments
- (ii) Subject completed instruments

- Rating Scale
- Interview schedules-guides
- Tally sheets
- Flow charts
- Performance checklists
- Time and Motion logs
- Observation Forms
- Questionnaires
- Self-checklists
- Attitude scale
- Personality inventories
- Achievement/Attitude tests
- Projective devices
- Socio-metric devices

(Denzin & Lincoln, 2015)
The researcher usually chooses the type of instrument(s) to use based on the research needs and questions. A mis-selection of any instrument leads to misapplication and this leads to mis-usability as well as misuse of statistical tool/test. All subjects-completed instruments must be accompanied with both validity and reliability. While all researcher-completed instruments need only validity. To find the reliability of an instrument researchers use the four (4) general estimators:

(i) Inter-Rater/Observer Reliability- Raters and observers give consistent answers or estimates.
(ii) Test-Re-test Reliability – Consistency of a measure evaluated over time.
(iii) Parallel-Forms Reliability – Reliability of two tests constructed from the same content.
(iv) Internal Consistency Reliability – Consistency of results across items often measured with Cronbach’s Alpha.

(Denzin & Lincoln, 2015)

(v). Research Data

The Centre for Innovation in Research and Teaching (CIRT) in 2012 described research as a systematic inquiry used to describe, explain, predict or control some observable phenomenon. The Data, to be collected must reflect the form of research in question i.e. Is it a Basic Research? – which is descriptive in nature and explain phenomenon or Is it an Applied Research? Which provide information that could be applied to people and environment or Is it an Evaluation Research aimed at examining a processes and outcomes and problems and their solutions or rather an Action Research? That is often conducted within a program, organization or community (CIRT, 2012).

Common mistakes encountered in Educational Research

Researchers, Universities, Educational bodies (Glem & Roseaun, 2011, Qualitrics, 2010) identified common mistakes encountered in research, among which include:

1. Failure to carefully examine the literature for similar, prior research.
2. Failure to critically assess the related empirical.
3. Failure to specify the inclusive and exclusion criteria for the selected subjects.
4. Failure to perform sample size analysis before the commencement of the study.
5. Failure to report missing data dropped subject and use of intention to treat analysis (Glem & Roseaun, 2011:1 – 6).

Connectivity among Research Components

- Population
- Instrument
- Data
- Statistics

Population - a collection of individuals/objects for study/scientific query
Sample - The sample is drawn from the population
Instrument – Use for collection of data from sample
Data - Data are collected from sample
Statistics - Needed/used to determine how likely the sample results are reflected

Type of Errors Committed by Researchers in Educational Research

1. Sampling error: is the deviation of the selected sample from the true characteristics, traits, behaviours, qualities or figures of the entire population.
2. Population specification error: This type of error occurs when the researcher selects an inappropriate population from which data is obtained (Qualitrics, 2010)

However, in their presentation on Errors in Research tagged “Team 18” (Abinesh, Raghu, Rajesh Waran, Sriram & Vijayalokshine, 2013) categorized errors in research as:
Fig 2: Categorization of Common Errors in Educational Research

![Diagram of Errors]

(i) Quantitative errors
(a) Population specification error
(b) Sampling error
(c) Selection error
(d) Non-response error
(e) Surrogate information error
(f) Measurement error
(g) Experimental error

(ii) Qualitative errors
(a) Selective observation
(b) Inaccurate observation
(c) Over generalization
(d) Made-up information
(e) Expost-factor hypothesizing
(f) Illogical reasoning
(g) Ego involvement in understanding
(h) Premature closure of inquiry
(i) Mystification

Source: Adapted from Abinesh, Raghu, Rajesh Waran, Sriram & Vijayalokshine, (2013).

3. Other errors identified are on the area of instrumentation and research design and selection of the statistical test. In order to avoid errors, hence the need to select appropriate statistical test.

Selecting the Correct Statistical Tests: Researchers should endeavour to select the correct statistical test that matches the research question, population, hypotheses, research design, sample and types of data (Nominal, Ordinal, Interval and Ratio) putting into consideration the basic assumptions of their applications.

Fig 3 Selecting Statistical Tests

Inferential Statistics

Parametric
1. T-test (Independent Sample)
2. T-test (Dependent Sample)
3. Z-test
4. Anova
5. Ancova
6. Manova
7. PPMCC
8. Multiple Regression
9. Factor Regression

Non-Parametric
1. Chi-Square (X²)
2. Spearman
3. Mann-Witney U-test
4. Sign Test
5. Median test
6. Wilcoxon Sign ranked Test
7. Kruskal Wallis
8. Friedman Test
Assumptions

1. Exclusively independent observations
   i.e. unbiased selection or sampling
2. Necessary homogeneity of two or more
   Samples i.e. equal variance.
3. Samples should be from normally assumptions.
4. Data must be in interval or ratio scale.

Assumptions

Non-parametric treat data measured on nominal or ordinal scales. They are distribution free test that do not requires any distributed population.

Attributes

1. More appropriate for hypotheses testing.

Source: Adapted from: James (2016). What Statistical Analysis Should I Use?

Table 1 Guide on Choosing the Appropriate Statistical Test

<table>
<thead>
<tr>
<th>Independent Variable Measurement</th>
<th>Number of Independent Variables</th>
<th>Dependent Variable Measurement</th>
<th>Types of Observation</th>
<th>Hypothesis Type</th>
<th>Statistical Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal</td>
<td>1</td>
<td>Interval/Ratio</td>
<td>Independent</td>
<td>Population to population</td>
<td>Inspection of means</td>
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<td>Population to sample</td>
<td>One-sample t-test</td>
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<td>Sample to Sample</td>
<td>One-sample ANOVA</td>
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<td>ANOVA</td>
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<td>Nominal</td>
<td>2 or more</td>
<td>Nominal</td>
<td>Comparative Hypothesis</td>
<td>Population to population</td>
<td>Inspection of percentages</td>
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<td>Population to sample</td>
<td>Multiple one-sample Chi-square</td>
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<td>Contingency table</td>
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<td>Log-linear models</td>
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<td>Nominal</td>
<td>2 or more</td>
<td>Nominal</td>
<td>Conclusion</td>
<td>Population to population</td>
<td>Inspection of percentages</td>
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<td>Log-linear models</td>
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</tbody>
</table>
### Relationship Hypothesis

<table>
<thead>
<tr>
<th>Relationship Hypothesis</th>
<th>Comparative Hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal 2 or more Nominal Independent</td>
<td>Nominal 1 Nominal Independent</td>
</tr>
</tbody>
</table>

- Nominal: 2 or more
- Ordinal: (continuous)
- Dependent
- Analysis required
- Global

#### III. CONCLUSION

From the discussion being presented so far the following conclusion could be made:

1. Lecturers and students both at Postgraduate and Undergraduate level, perceived research and statistics as friendly, difficult, hostile or mysterious.
2. Many researchers are committing errors in their research methodologies and selection of statistical tests.
3. The paper identified common mistakes in research and misuse of statistical test and suggested ways for improvement.

#### IV. SUGGESTIONS

The paper suggested the following for the improvement of research and use of statistical tests/tools:

1. Researchers should be careful and critical in selecting the design, sample, instruments and statistical tests.
2. Departments in the Faculty should change their status quo and employ the use of variety of statistical tests in line with the analysis required and global happenings.
3. Lecturers and Postgraduate students should attend conferences both national and international regularly to meet the challenges of the changing world in terms of research methodology and statistical application.

#### REFERENCES


resources/tutorials/research designs on 14th October, 2016 @ 2:30 am.

