EDF 6481: Foundations of Educational Research
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FINAL

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Component	Article Authors	FWH Chapters 1-12	FWH Weekly Chapter	Your Evaluation	
1: Research Problem ~~or Justification~~ (FWH Chapter 2) **Make sure you write about the problem this last time.**	(p. 1-5) Nigerian secondary students are showing a consistent and clear lack of scientific literacy, poor achievement and performance levels in science subjects, and an overall negative attitude toward science subjects (especially in the area of biology) despite Nigerian science teachers having a high level of scientific literacy and understanding of science concepts. Given the push toward technological and scientific advancements in the 21st century in Nigeria, this gap poses a large problem that	(p. 27) Research problems worthy of study should highlight areas of concern that clearly need improvement, difficulties that need to be eliminated, and questions that need solving. Research problems are derived from current practice observations, gaps in literature, or personal biography and history.	(p. 266) The goal of experimental research is to not only identify a relationship between variables but also examine and explore the causes for such a relationship.	From the outset Nwagbo did an excellent job identifying the core problem in Nigerian science classrooms as it relates to the larger purpose of advancing the technological and scientific sector of the developing country. The problem was identified using previous research, current practice observations, and personal history as the author had a long history of studying this aspect of Nigerian culture. Nwagbo not only identified the research problem but set out to explore the causes, fitting of an experimental research design.	

	needs to be addressed by science teachers in Nigeria.				
2: Literature Review (FWH Chapter 3)	Research was cited for the following topics: -current performance and attitude of Nigerian students in relation to science -the benefits of inquiry method teaching in science -the components of exploratory method teaching -definitions of scientific literacy and attitude toward school subjects The cited previous work indicated that there is a chasm of understanding and attitude toward science concepts between Nigerian science teachers and their students. A second concerning gap was shown in relation to the above mentioned teaching methods and their effect on scientific literacy in particular.	(p. 38) FWH stated that researchers need to not only be able to locate others' work on their research subject but be able to evaluate, synthesize, and apply the findings to their study. (p. 52) The body includes cited studies relating to the research problem at hand, often showing the gap in research that currently exists. The summary presents a cohesive picture of what is known and not known about the area of study. The conclusion shows what the researcher feels are appropriate courses of action based on the compiled evidence as well as stating the research question again.	(p. 285) The guiding questions that FWH used for evaluating research reports points to two pieces that must be present in a literature review: -Has previous work been adequately covered? -Is it clearly connected to the present study?	Nwagbo offered a wide variety of previous research in this report. All of the main points to the study were addressed; however, it was somewhat shallow thus showing the gap in literature specifically relating to this study: "There was paucity of literature on the use of the above methods on students of different levels of scientific literacy, hence the need for the study" (p. 5).	
3: Hypotheses and Research Question (FWH Chapter 5)*	Hypothesis(es) (p. 6) Four null hypotheses (nondirectional) were stated: 1. There is no statistically significant difference ($P<0.05$) in the mean achievement scores of students of high, medium and low levels of scientific literacy taught biology using guided inquiry method and those taught biology using the expository method.	(p. 83-84) Three advantages to stating hypotheses were given by FWH: -forces researchers to focus specifically on the outcomes of the study and their applicable results -allows researchers to make specific predictions—a clear component of experimental science -helps researchers to ensure they are in fact investigating	(p. 265) When properly applied, experimental research is the best method for testing hypotheses about cause-and-effect relationships.	Nwagbo clearly identified both the hypotheses and research questions that guided the study. All four hypotheses show the relationships to be investigated and the research questions go hand-in-hand with those outlined statements. I appreciate that Nwagbo laid out so transparently both the hypotheses and guiding questions. They are very clearly in line with the scope and purpose of the research	

	2. There is no statistically significant interaction ($P<0.05$) between teaching methods and scientific literacy levels, on achievement in biology. 3. There is no statistically significant difference in the mean attitudinal scores of student of high, medium and low levels of scientific literacy, taught biology using the guided inquiry method and those taught biology using the expository method. 4. There is no statistically significant interaction between teaching methods and scientific literacy levels, on attitude towards biology. Research Question(s) (p. 5) Four specific research questions were stated outright: 1. What are the comparative effects of teaching methods (guided inquiry and expository) on the mean achievement scores of students of different levels of scientific literacy, in biology? 2. What are the interactive effects of teaching methods and scientific literacy levels, on students' achievement in biology? 3. What are the comparative effects of teaching methods (guided inquiry and	a relationship—the basis for quantitative research.		problem and experimental research designs.	

	expository) on the mean attitudinal scores of students of different levels of scientific literacy, in biology? 4. What are the interactive effects of teaching methods and scientific literacy levels, on students' attitude to biology?				
4: Variables (FWH Chapter 5)	Dependent (if any): -mean achievement scores of scientific literacy (quantitative) -mean attitudinal scores (quantitative) -attitude towards biology (quantitative) -achievement in biology (quantitative) Independent (if any): -method of instruction: inquiry and expository (categorical) -interactive effects of teaching methods and scientific inquiry (quantitative)	(p. 78) -Quantitative variables exist along a continuum from less to more with numerical values sometimes being assigned to indicate how much of the variable an individual possesses. -Categorical variables do not vary in degree, amount, or quantity but are qualitatively different. FWH stated: "researchers choose certain variables to investigate because they suspect theses variables are somehow related and believe that discovering the nature of this relationship, if possible, can help us make more sense out of the world in which we live."	(p. 265-266) Experimental research seeks to influence a particular variable in order to identify its affect on another variable. Researchers using this design manipulate an independent variable deliberately and directly in the way they choose with the intention of observing a difference in the dependent, constant variable. (p. 277) FWH: "Factorial designs extend the number of relationships that may be examined in an experimental study. They are essentially modifications of either the posttest-only control group of pretest-posttest control group designs (with or without random assignment), which permit the investigation of additional independent variables."	The variables, though not stated outright, were easy to identify based on the clarity of other portions of the study. They completely fall in the line with the purpose of experimental research in that Nwagbo used two different teaching methods to attempt to manipulate achievement and attitudinal scores. The independent variable of teaching method was carefully manipulated and its effects on achievement scores and attitudinal levels were observed—a complete experiment. The design chosen by Nwagbo allowed for further investigation into the interaction of a combination of factors, such as scientific literacy and teaching method on attitude toward biology.	
5: Sampling plan (FWH Chapter 6)	(p. 6) Simple and stratified random sampling were used resulting in a sample consisting of one hundred and forty seven (147) SS11 biology students from eight intact classes randomly sampled from four senior	(p. 94) -Simple random sampling is one in which each and every member of the population has an equal and independent chance of being selected. (p. 95) -Stratified random sampling	(p. 275) Quasi-experimental designs differ from true experiments in that random assignment to control and experimental groups is not in place.	Nwagbo gives very little information in regards to the sample. I was left wondering about demographic data such as age, gender, and other various subject characteristics. Nwagbo also fails to state how the sample was stratified. I wonder	

	secondary schools in Nsukka, Enugu State, Nigeria. No demographic data was given.	is a process in which certain subgroups, or *strata*, are selected for the sample in the same proportion as they exist in the population. (p. 92) FWH cautions that a major weakness of published research reports is insufficient amounts of demographic data concerning both population and sample. This makes generalizability difficult. (p. 95) Stratified random sampling increases the likelihood of representativeness and ensures that key characteristics of individuals in the population are included in the same proportions in the sample.		what the criteria were for placement in the control and experimental groups. Because of the lack of clarity, I am concerned about the generalizability to the population as a whole.	
6: Instruments, including validity and reliability (FWH Chapter 7-8)	Instrument(s): (p. 6) -Biology Achievement Test (BAT) -Attitude to Biology Scale (ABS) -Scientific Literacy Test (SLT) **Validity Evidence:** <u>BAT</u>: -Content validity was accomplished by making sure that the test items reflected the specifications of the test blueprint. -Face validation was accomplished by evaluation of	(p. 112) Validity and reliability are crucial components that make it possible to draw defensible inferences from collected data using instruments that give consistent results. (p. 148) FWH: validity (appropriateness, correctness, meaningfulness, and usefulness of specific inferences made based on data collected) is the most important piece when deciding on instrumentation used in a study. There are	(p. 285) Research reports should adequately describe instrumentation, showing validity and reliability as much as possible so that solid inferences may be confidently made by the researchers.	Nwagbo describes the three instruments used in this study clearly and separately, showing validity and reliability using various statistical measures as well as external review for the BAT namely. I believe there is sufficient detail and measures which show that all three instruments are reliable and valid to the point of being able to draw confident inferences from the data collected. The instruments well thought out and a natural fit for the scope of this study.	

	the items by four experts from related fields of study in the University and four-experienced secondary school biology teachers. The Kuder-Richardson Formula 21 was used and determined an internal consistency of 0.77. ABS: - Scale was modified to suit biology students of this study by restructuring the items referring to science/scientists to read biology/biologists. (p. 7) **Reliability Evidence**: ABS: - Reliability of the instrument was re-established using coefficient (Cronbach) alpha reliability estimate and the calculated value was 0.90. -SLT: Reliability was established statistically in all three divisions as follows: • Section A & B: using K-R 20: 0.71 and 0.76 respectively • Section C (essay): using scorer (inter-rater) reliability estimate was used and the value was 0.93 • Section D: Cronbach Alpha= 0.70	three types of evidence of validity: content-related, criterion-related, and construct-related. FWH states that the validity of a study depends on the amount and type of evidence.			
7: Procedures	-Regular biology teachers were trained by researcher for 4 weeks, 2 hours per week.	n/a	n/a	The procedures were clearly delineated. I appreciate how Nwagbo trained the teachers in	

	Teachers were given specific lesson plans and trained to use their method (inquiry or expository) to a mastery level determined by researcher. -SLT was administered to both groups as a pre-test only. -Afterwards, BAT and ABS were administered before treatment began. -6 weeks of treatment for both control (expository teaching method) and experiment (inquiry method) -Immediately after 6 week treatment both groups were given the BAT and ABS again.	[redacted]		the study to ensure uniformity. 6 weeks is a fair amount assuming that students had more than one class or session per week. The procedures are straightforward, simple, and uncomplicated. The same concept was taught two different ways, which Nwagbo outlined in great detail in the report. I do not see a need to add or change anything concerning the way this study was conducted.	
8: Ethics (FWH Chapter 4)	No ethical issues are specifically noted by Nwagbo.	(p. 63) FWH stated three issues every researcher should address: "protecting students from harm, ensuring confidentiality of research data, and the question of deception of subjects."	(While ethics issues are clearly important in every research study, FWH does not specifically address them in chapter 13.)	Given the secondary level of students, it can be assumed that students are old enough to consent but I would like to see that specifically stated. Deception does not seem to be an issue and there does not seem to be a potential physical or psychological harm. Most importantly, I would have liked to see a small paragraph addressing that confidentiality was ensured. While this is a study conducted at an international school, I hope something equivalent to an Institutional Review Board was used to approve this particular study.	
9: Internal validity (FWH Chapter 9)	**Mortality:** No loss of participants reported **Instrumentation:** Teachers	(p. 167) The best method for controlling threats to internal	(p. 284) FWH: "The trick, then, is to identifying threats to internal	**Subject Characteristics** were not addressed specifically but some control was present based	

	were thoroughly trained by researcher thus controlling data collector characteristics and bias. **Location:** Nwagbo does raise concern that the variance between materials and access to resources (based on type of instruction) could have played a role in results. **Testing:** 3 varying pretests were given, 2 of which were repeated post treatment **Subject Attitude:** Because this particular study focused partially on subject attitude, it was well controlled and documented. **Implementation:** Teachers were trained by researchers and as far as was reported, no change in implementation individuals occurred.	validity is to identify them prior to the study. By doing so, researchers can make plans for each threat to minimize its impact on the data collected and resulting inferences and conclusions.	validity is to first think of different variables that might affect the outcome and, second, to decide, based on evidence and/or experience, whether these things would affect the comparison groups differently. If so, the influence of these factors may provide an alternative explanation for the results."	on the sample size as well as by the use of stratified sub grouping. Given the lack of demographic data reported, it's difficult to say there was sufficient control over this threat. **Location** was held constant offering some control however it is not stated whether similar conditions existed in each of the classrooms and schools. **History** was not addressed so I am left to assume no extraneous incidences occurred. **Maturation** as far as is stated does not pose a threat in that pre-test data was not used to stratify the control and experimental groups. **Regression** is not a factor because of the design and short length of this study. **Testing:** Use of pretest and posttest in this study may have created a "practice effect" for participants (p. 179).	
10: Data Analysis Techniques (FWH Chapter 10-12)	-Data was reported in text and table format using descriptive statistics and inferential statistics -Hypotheses were tested using analysis of covariance -Research questions were answered using mean and standard deviation -A post-hoc multiple comparison test (scheffe) between three mean scores was also applied	(p. 220) Inferential statistics allow researchers to make the valuable inferences necessary to make educational research studies worthwhile. This form of statistical analysis helps translate findings from a sample to the population as a whole. (p. 236) ANCOVA is used when groups are given a pretest	(p. 267) Randomization is a crucial element to experimental designs and when random assignment to control and experimental groups is not feasible, caution in data analysis is required. (p. 248) FWH recommends the use of inferential statistics only as they are intended: to generalize to the population as a whole, not to evaluate sample results.	The use of mean comparison for all three levels (high, medium, and low) of scientific literacy and also achievement scores was an appropriate use of descriptive statistics. The use of ANCOVA, while proper for this study, should be used with caution as randomization was not utilized for grouping.	

		related in some way to the dependent variable and their mean scores on the pretest are found to differ. ANCOVA enables the researcher to adjust the posttest mean scores on the dependent variable for each group to compensate for initial differences between the groups on the pretest.			
11: Results	-BAT scores: significant difference post-treatment in the High level with guided inquiry compared to expository (62.69; 54.78). No significant differences in Medium or Low groups • ANCOVA for the above difference showed: teaching method was significant (P<0.05) at an F value of 4.464; and scientific literacy at F= 7.666 as significant (P<0.05) thus hypothesis 1 is rejected. -No significant interactions between teaching methods and scientific literacy were found when comparing adjusted mean and SD scores of achievement -ABS scores: mean attitudinal scores increased for those in the expository group in all three levels, while those in the	n/a	n/a	The reported results were consistently compared with previous work where applicable. I was quite surprised that more significant differences were not found and even more that the guided inquiry method produced a negative attitudinal shift across all three literacy levels. Overall the reported data adequately covered all of the main focus points of the study.	

	inquiry group showed losses • ANCOVA results for teaching method and scientific literacy levels on attitude in biology showed no significant difference (*F* values of 0.424 and 0.284 respectively where *P*<0.05)			
12: Conclusions, Recommendation, and/or Limitations:	Conclusions: (p. 16) • Guided inquiry method was significantly better than expository in relation to cognitive achievement gains for all levels of scientific literacy. • Guided inquiry method produced a negative attitudinal shift in score while expository method produced a positive attitudinal shift in score, across all literacy levels. • All groups showed positive attitude toward biology for both teaching methods. • There were no significant interactions between teaching method and scientific literacy on	n/a	n/a	Conclusions: In my opinion, Nwagbo did an excellent job summarizing the findings of the study without creating overarching and out of place inferences. The outlined conclusions were right on par with what I concluded as I delved into the data analysis compared to the study as a whole. Recommendations: There is one main recommendation with which I differ from Nwagbo and see a need for revision. While inquiry method does seem to enhance cognitive achievement, making the blanket statement that inquiry method alone should be sought is out of place. I believe that for the sake of attitudinal gains and scientific literacy gains, expository method should be utilized to some extent as well. It can arguably be stated that given the desire

	either achievement or attitude concerning biology based on BAT and ABS respectively. Recommendations: (p. 17) Science teachers should: • Utilize guided inquiry for teaching biology especially for high literacy level students. • Teach for inculcation of scientific literacy. • Teach for acquisition of positive scientific attitudes. • Select methods that will enhance achievement and has potential for development of critical thinking and creative abilities in the students. Limitations: (p. 12, 16) • "It may be that the guidance given to the guided inquiry group and the variety of instructional materials used for teaching, gave them an edge over their expository counterparts, by providing channels for objective	[redacted]	to move Nigeria to a more technologically advanced nation, all three components—cognitive scores, attitudes toward science, and scientific literacy—need to be improved. This study clearly showed that inquiry method alone cannot achieve gains in all three areas. Limitations: The way in which Nwagbo wove limitations into the report itself was slightly confusing. That aside, there are some that were mentioned and I agree with them entirely. I will also add that I am concerned slightly as to the generalizability of these findings without a replicated study in place that clearly delineates implementation of the following: -clarity of thorough demographic data -clearly addressed ethical issues accounted for -truly randomized sampling beyond use of intact classrooms	

	reasoning and creative thinking ability that are likely to enhanced achievement in biology." • "However, one can say that since attitude, unlike interest, is cultivated over a long period and is not easily influenced, the biology students of this study may not have been affected much by the treatment (teaching using the two methods) giving the short period." • Extraneous variables such as overloaded curriculum, rigid school calendar, lack of laboratory equipment, and others could contribute to poor cognitive achievement performance, which this study simply could not control.	[redacted]		

