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A Statistical Analysis of Students' Attitudes Towards Statistics: A Case Study of Undergraduate Bachelor of Science Students at the University of Fort Hare

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ABSTRACT Students of science disciplines at Fort Hare University must take a course in statistics along with other courses offered in their own disciplines. The goal of this study is to evaluate the general attitude of enrolled science students towards statistics module at the beginning and at the conclusion of a statistics module. Thus, to achieve the goals pursued through this study, a strategy of looking for set pre-test and post-test questionnaires was used by investigators at the beginning and the conclusion of the module. Although the learners did demonstrate moderate anxiety towards the course, anxiety anyway as compared to the beginning of the course increased by twelve percent at the conclusion of the module. In addition, a significant negative swap in their attitudes regarding the resolution of assignments in the groups was also noticed amongst the students at the end of the study. The use of real examples and the characteristics of the instructor as a factor that can help change their attitude positively towards statistics course have also been reported by students.

INTRODUCTION

At this period of time, learners' attitudes regarding statistics modules have sustained a growing awareness about issues in the teaching of statistics. In the investigation of statistics module teaching, attitudes concerning statistics are usually widely and openly explained as a complex notion approaching unequivocal, never the less associated tempers pertaining to sympathetic or unsympathetic replies with connection to statistics and statistical intellect (García-Santillán et al. 2014; Gaguk 2015; Chiesi and Primi 2009; Gal et al. 1997; Schau et al. 1995). The eminence of attitudes in the surroundings of fundamental statistics modules is widely accepted (Ramirez et al. 2012; Slootmaeckers et al. 2014; Gal et al. 1997; Leong 2006). In the social and behavioral sciences, students are generally intimidated by figures (Allen et al. 2016). As such, taking a course in statistics remains a problem. Coping with statistical concepts in order to obtain the necessary knowledge of the course is challenging (Haines 2015; Finney and Schraw 2003).

Such dissentient attitudes are most of the time pondered as major barriers to fruitful intellect (Kindratt et al. 2015; Waters et al. 1988). In several university programs, students in the science disciplines are often forced to take a statistics course because the course is considered as a prerequisite for other courses in their disciplines. Despite the students experiencing many difficulties, the course is deemed necessary to help them acquire a better understanding and improve their quantitative and qualitative research abilities (Kiener et al. 2015). On the basis of evidence of elements in effect on the attitude of students towards the statistics course, the authors noted, however, that there is a necessity of a systematic research to be carried out on how best to offer the course to students. Unlike the discipline of science, in other disciplines such as the social sciences, among others, the course of statistics is based on anecdotal reports, but science students are facing the course of statistics that is based on evidence and application of concepts to real facts (Farahany 2016). In addition, investigations undertak-

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en in other academic fields may have a restricted contribution to science teachers but the applications of these teachings can have a great and important contribution to the discipline of science. As a result science educators are saddled with the responsibility of teaching these students in the specific and related discipline of science (Oztabak et al. 2015).

At the time the investigators were commissioned to conceive and teach a science undergraduate statistics module, they were hit by the deficiency of documented investigation focusing on implementation and lecturing, since the investigators were apprised of the attitude of fear, nervousness and ambivalence that characterize numerous undergraduate students in general and those in the science disciplines in particular when enrolling for a statistics module (Chamberlain et al. 2015). The authors took the initiative to deliver a systematic investigation based on the best possible way of teaching statistics courses to bachelor's degree students of science. This article describes and interprets the results and proposes some suggestions for the study.

METHODOLOGY

Area and Specimen

The survey was coordinated at Fort Hare University located in the Eastern Cape Province in South Africa. The principal investigators teach, among other courses, applied statistics to Bachelor of Science degree students at the first year level. The survey questionnaires were administered to these students in the same year they gained admission into the institution. Two assessments were recorded. One, students were assessed at the beginning of the course before going through statistics classes, and two, they were also assessed after the completion of the course. In all, 126 students took part in the survey. By the end of the survey, 109 students had fulfilled the pair of the inceptive and termination of module questionnaire items assessments. As presented in Table 1, of the 109 students who completed the surveys, 50.5 percent of respondents were male, all enrolled for a course in applied statistics, and 80.7 percent of participants were between 18 and 21 years old (inclusive), with a range of 18 to 41 years and above. A comprehensive percentage (30.2 percent) of the students stated that they are not comfortable with mathematical word problems.

Table 1: Biographical information in percentages

	n	*%*	*Cum. %*
Gender			
Male	55	50.5	50.5
Female	54	49.5	100.00
Total	109	100.00	
Age			
18-21	88	80.7	80.7
22-30	17	15.6	96.3
31-40	3	2.8	99.1
≥41	1	0.9	100.00
Total	109	100.00	
Program of Study			
Plain Bachelor of Science	7	6.4	6.4
Soil Science	17	15.6	22
Bachelor of Science in Agriculture	85	78.0	100.00
Total	109	100.00	

Source: From the data

Ethical Mindfulness

Ethical consent was acquired from the University of Fort Hare's ethical committee prior to the beginning of the survey. The survey questionnaires were issued to students enrolled for STATISTICS 111 for the 2015 academic year in an agreeable sample. The aims of the study were enumerated to the students before their participation in the study. Completed questionnaires were kept with high anonymity to protect respondents' identities.

The Applied Statistics Module

The module being assessed was Introduction to Applied Statistics, STA 111, which is a first-year course, developed by the department of statistics, University of Fort Hare (UFH), Alice campus. This is a compulsory course for all Bachelor of Science students irrespective of the degree program to which the students are admitted. In this course, students are taught basic computer skills and some elementary statistical analysis techniques. The main basis of STA 111 is to empower these learners with fundamental statistical comprehension that will enhance their skill in conducting basic statistical analysis for their research projects in their final year of study at the institution, aside from future applications. The module also covered basic statistical con-

cepts and descriptive statistical estimates such as graphical meaning of data, inferential statistics that includes t-tests, Chi-square test, one-way analysis of variance, linear regression, and diverse nonparametric tests. Moreover, a good knowledge of the course also aids students in their interpretation of statistical outputs.

Survey Development

Earlier works by Reeinna (2014) and Stanisavljevic et al. (2014) investigated the attitudes of the students towards studying statistics. However, these works were limited in their applications to the university undergraduate students. Moreover, learners' attitudes to desired intellectual and educating styles when enrolling for modules in statistics were not probed by these authors. In an effort to address these uncovered grounds, a 28-item survey that incorporated declarations concerning three main areas was distributed. The areas covered are overall attitudes regarding the study of statistics, desired studying styles in statistics modules, and desired lecturing styles in statistics modules. Moreover, few questions were queried about elementary demographic characteristics such as age, program of the study, and the gender of the respondents. The 28-item survey questionnaire is structured such that each student would indicate the range to which learners agreed with each declaration using a five-point Likert scale that ranged from "strongly disagree" (rating of 1) to "strongly agree" (rating of 5). The primary set of queries on overall attitudes to statistics modules included 10 queries related to learners' overall attitudes towards enrolling for a statistics module and computer utilization. The categorization used in this study was based on Schau et al. (1995) titled "The Development and Validation of the Survey of Attitudes toward Statistics". The 10 questions considered by the authors were grouped into three components (Table 2): self-reliance about enrolling for statistics, fright and nervousness about enrolling for statistics and students' serenity with computer utilization.

The second set of queries, which is on learners' favorites related to their intellectual styles when enrolling for statistics module, included seven queries about different items they believed would be relevant to them; all the queries were summarized into three distinct components (Table 3): identically loaded home works (in designation of scores), a liking of working together

Table 2: Different factors of overall attitudes towards statistics

Overall attitude to statistics		
Component 1	*Component 2*	*Component 3*
Self-reliance	*Fright and Nervousness*	*Computer Comfort*
I am serene in my prowess to do ably in statistics	When thinking about statistics, I feel scared	I am pleasant using a computer for more than elementary occupations
I feel comfortable using numbers	I am troubled that I will not comprehend statistical concepts	I like grasping up to date computer programs
Mathematical word queries are effortless to me	I am anxious that I will need supplementary assistance to perform well in a statistics course	
	This will doubtless be the most strenuous module I have ever taken	
	I am worried about not being clever enough in the statistics class	

Table 3: Different factors of preferred intellectual styles

Preferred intellect styles		
Component 1	*Component 2*	*Component 3*
Equally Loaded Home Works	*Preference Team Effort*	*Preference for Real Practical Problems*
I desire faintly loaded home works	I master best when I study as a group	I am an optically trainee
Weekly quizzes facilitate my intellect	Group tasks are non-objective	Real life illustrations help me understand a concept
		Practice helps me perceive concepts

in different groups, and a liking of practical examples related to real problems.

The third set of queries was associated with the learners' desires as they concern the investigator's lecturing styles during statistics classes. These incorporated eleven questions which were later summarized into three non-identical components (Table 4): a feeling of the educator's scheduling and all-inclusive success, the educator's comfort and precision, and the educator's aptness to utilize captivating visual supports and tangible illustrations from the sciences.

For both pre- and post-test grades from the three groups comprising 28 queries, a satisfactory internal consistency and reliability (Cronbach's alpha coefficient of 0.87) was obtained from the analysis.

Data Collection Method

Survey questionnaires were issued to science students who enrolled for a statistics course at the beginning of the semester, prior to attending their first lecture in their statistics course. They were done in such a way that the involvement in the investigation was non-compulsory and no student's identification information was indicated on the answered questionnaires. Students were told that following the first survey, a second investigation questionnaire would be issued to them at the conclusion of the semester's statistics course. From 126 Bachelor of Science students entitled to fulfill the survey, 109 (86.5%) fulfilled the survey questionnaires before the statistics module, and 111 (88%) replied to the survey by the conclusion of the statistics module. To have a balanced design, statistical analysis was performed on 109 completed questionnaires from pre and post-test surveys. Moreover, these 109 pairs of survey questionnaires (pre-and post-test) were assumed to be standing for effective combinations of similar categories of learners.

Data Capturing and Analysis

Data was coded and captured, both descriptive and inferential statistical analyses were used in this study. Elementary descriptive statistics for each statement were calculated, and the average grade for each survey statements was analyzed for possible variations in learners' replies between the beginning and the end of the module, using match *t*-test. When analyzing the data, a significance level of five percent was set as a thresh holder just to verify the statistical significance of the results and the Statistical Package for Social Sciences (SPSS version 22) was utilized.

RESULTS

In this section findings based on Descriptive and Inferential statistics will be presented.

Descriptive Statistics (Beginning of the Module)

The descriptive statistics for science learners' replies prior to starting a statistics module (pre-assessment) are displayed in Tables 5, 6 and 7, and what is purely an inclusive synopsis and certain high points are delineated in this write-up. All grades designate prospective replies between 1.0 and 5.0, with grades approach-

Table 4: Different factors on preferred teaching styles

Preferred teaching styles		
Component 1	*Component 2*	*Component 3*
Planning and effectiveness	Comfort and precision	Tangible and visual
Effectiveness usage of office working hours	Tolerance	Providing tangible illustrations
Prompt riposte to email messages	Comprehensive explanations	Displaying lecture notes or power point-format slides show
Assigning punctual reply	Hospitability	
Thoroughly comprehension of statistics		
Utilizing ocular aids of things to elucidate concepts		
Appropriate pace (not too quick, not too steady)		

ing 5.0 revealing stronger accordance with the survey statement.

Overall Attitudes Related to Statistics

Learners' general attitude regarding statistics at the beginning of the module (Table 5) can be condensed as reasonably self-reliant (Mean score of 3.3), somewhat by 6.6 percent as compared to the beginning of the course). From the results displayed in Table 5, students fear statistics significantly (mean score of 3.32) and the fear has increased by 8.1 percent as compared to the level where it was before the test. Students already have a feeling or belief that statistics will be the most arduous module they encountered (mean score of 2.95) and the feeling has increased by 17.5 percent after writing the test and students are distressed about not having done well enough in the statistics module (mean score of 3.11) and the concern has increased by 12.7 percent as compared to the beginning of the course. All of these factors can lead to a student developing negative attitudes towards statistics, as this can be seen through students losing confidence in their ability to do well in a statistics course (mean score of 3.73, dropping by 7.4 percent as compared to the average score at the beginning of the course).

Preferred Intellect Styles

From the output as displayed in Table 6, students seem to have strong views about what they perceived would assist them do better in a statistics course prior to the beginning of the module. From the result, students prefer individual assignments rather than group assignments which make some to simply rely on the solutions provided by their peers (mean score 2.75, increasing by 23.3% as compared to the beginning of the course), and it has been noticed that students preferred real life examples of statistical concepts, which help them better understand the course (mean score of 4.11). But the rest of the factors considered in Table 6 were not significantly affected, meaning the attitude of the students towards statistics was the same on the pre- and post-test survey.

Preferred Teaching Styles

Students appeared not to have a preferred teaching styles as shown in Table 7. When it

Table 5: Averages (M), standard deviations (SD) grades and match sample t-test grades of the 'attitude related to statistics' grade for pre- and post-test reply

Items	*Pre-test*		*Post-test*		*Match sample t-test statistic*	*Remark on amelioration % growth/ drop*
	M	*SD*	*M*	*SD*		
Attitude Related to Statistics						
Component 1 (Self-reliance)						
I am positive in my ability to perform well in a statistics course	4.03	0.68	3.73	0.93	3.31*	-7.00
I feel confident using figures	3.83	0.80	3.79	0.96	0.53	-1.00
Mathematical related word problems are easy for me	2.81	0.93	2.61	0.99	1.67	-7.20
Component 2 (Fright and Nervousness)						
When I think about statistics I feel worried	3.07	1.29	3.32	1.23	-2.08*	+8.10
I am concerned that I will not master the concepts of statistics course	2.15	1.20	2.60	1.24	-1.73	+20.9
I am anxious that I will need supplementary help to do well in a statistics course	3.94	1.06	4.10	0.83	-1.63	+4.06
This will certainly be the most arduous module I have ever grasped	2.51	1.31	2.95	1.25	-3.68***	+17.5
I am distressed about not being clever enough in the statistics module	2.76	1.20	3.11	1.16	-2.64**	+12.7
Component 3 (Computer Comfort)						
I am serene using a computer for more than elementary activities	4.01	1.04	3.91	0.87	0.98	-2.50
I like intellect new computer programs	3.80	1.19	3.55	1.16	2.01*	-6.60

Key: *= p<*0.05* **= p<*0.01* ***= *p<0.001*
Source: From the data

Table 6: Averages (M), standard deviations (SD), match sample t-test scores of the 'preferred intellect styles' grade for pre- and post-test reply

Items	*Pre-test*		*Post-test*		*Match sample t-test statistic*	*Remark on amelioration % growth/ drop*
	M	*SD*	*M*	*SD*		
Preferred Intellect Styles						
Component 1 (Identically Loaded Home Works)						
I prefer moderately loaded home works	3.77	1.07	3.60	1.13	1.23	-4.50
Weekly quizzes facilitate my intellect	3.77	1.24	3.79	1.01	0.07	+0.50
Component 2 (Preference for Team Work)						
I learn best when I study with others as a team	4.13	1.22	3.92	1.18	1.92	-5.10
Group assignments are unfair	2.23	1.35	2.75	1.35	-3.82***	+23.3
Component 3 (Preference for Visual Intellect)						
I am visual student	3.58	1.09	3.78	0.88	-1.39	+5.60
Concrete illustrations assist me perceive concepts	4.34	0.76	4.11	0.85	2.06*	-5.30
Practical intellect assists me apprehend ideas	4.06	0.98	4.13	0.90	-0.62	+1.7

Key: *= p<0.05 **= p<0.01 ***= p<0.001
Source: From the data

Table 7: Averages (M), standard deviations (SD), and match sample t-test scores of 'preferred educating styles' grade for pre- and post-test reply

Items	*Pre-test*		*Post-test*		*Match sample t-test statistic*	*Remark on amelioration % growth/ drop*
	M	*SD*	*M*	*SD*		
Preferred Education Styles						
Component 1 (Planning and Success)						
Success use of office hours	3.77	0.99	3.85	0.82	-0.68	+2.10
Well timed response to email	3.50	0.89	3.36	0.93	1.30	-4.00
Providing well timed response	3.75	0.95	3.78	0.73	-0.11	-0.80
Thoroughly understanding of statistics concepts	3.50	0.83	3.48	0.88	0.44	-0.60
Using visual supports of things to elucidate concepts	3.43	0.91	3.49	0.78	-0.50	+1.70
Appropriate pace (not too speedy, not too steady)	3.78	1.01	3.74	0.98	0.67	-1.10
Component 2 (Warmth and Clarity)						
Patience	4.20	0.80	4.06	0.82	1.38	-3.30
Clear explanations	4.38	0.67	4.30	0.79	1.03	-1.80
Approachability	4.17	0.90	4.18	0.83	0.00	+0.20
Component 3 (Actual and Perceptible)						
Delivering 'real life' illustration	4.07	0.87	4.10	0.90	-0.19	+0.70
Displaying notes or PowerPoint slides display	3.49	1.20	3.49	1.08	0.07	0.00

Key: *= p<0.05 **= p<0.01 ***= p<0.001
Source: From the data

comes to rather preferred teaching styles, students seem to have appreciated the styles used when they were being taught on pre- and post-test surveys.

It appears that the attitude of Bachelor of Science students at Fort Hare University is not negatively affected by teaching style.

Inferential Statistics (At the Beginning and the Conclusion of the Module)

The extent to which learners' attitudes and preferences regarding statistics module, intellectual styles and lecturing styles altered between the beginning and the end of the module is unveiled in Tables 5, 6 and 7, and an all-inclusive synopsis and certain focal points are written up here in the narrative.

Overall Attitudes Regarding Statistics

While the pre-test investigation demonstrated that learners exclusively revealed tolerable degrees of fright and nervousness towards enrolling for a statistics module, this was more-

over the one domain that showed the most considerable variations between pre-test (before module) and post-test (after module), as observed in Table 5. In illustration of this, consider the fact that learners' agreement with the declaration that 'students are confident in their ability to do well in a statistics module' fell 7.4 percent by the conclusion of the module (t [108] = 3.31, $p = 0.01 < 0.05$), and their agreement with the declaration that 'I like intellect new computer programs' fell 6.6 percent by the conclusion of the module (t [108] = 2.01, $p = 0.047 < 0.05$). Students' average agreement grade with the declaration 'when I think about statistics I feel worried' was 3.32 by the conclusion of the module, indicating an increase of 8.1 percent (t [108] = -2.08, $p = 0.040 < 0.05$) from the beginning of the module. Regrettably, at the conclusion of the module, there was only a slight and non-statistically significant growth of 4.06 percent in students' sympathy with the declaration 'I am anxious that I will need supplementary help to do well in a statistics module' (t [108] = -1.63, $p > 0.05$) compared to the beginning of the module.

Preferred Intellectual Styles

Whilst the swaps in this domain were not as stimulating as the swaps in fright and nervousness grades, the science students still revealed some crucial moves in preferences about intellectual styles between the beginning and the conclusion of the module (Table 6). Notably, science students appear to have undergone a bad record with the team-based intellectual perspective apprehended in the module, as corroborated by a 23.3 percent increase in accordance with the declaration 'group assignments are unfair' (t [108] = -3.82, $p < 0.05$); in addition, about twenty-eight percent of students who sympathized with the declaration 'group assignments are unfair' failed at the conclusion of the module. Surprisingly, eighty-two percent of students who agreed to the declaration 'real life illustrations assist me understand' (t [108] = 2.06, $p < 0.05$) passed at the conclusion of the module.

Preferred Educating Styles

As can be seen in Table 7, in general preferences for educating styles did not change the attitudes of all students by the conclusion of the module. Whilst all attitudes remained unchanged, the instructor educating styles that appeared critical to them at the beginning of the module had dropped slightly in influence by the conclusion of the module although not significantly. For example, "clear explanations" had declined in significance by 1.8 percent, but this decline is not statistically significant (t [108] = 1.03, $p > 0.05$).

DISCUSSION

The purpose of this investigation was to analyze Bachelor of Science students' overall attitude regarding statistics modules before and after taking a module in applied statistics.

From the aspect of descriptive statistics, the authors found that students reported a moderate general attitude towards statistics, with results confirming the findings of van der Weathuizen (2015). Students also reported a significant fear of statistics as reported by the findings of Förster and Maur (2015).

In general, students appreciated the generally preferred intellectual styles, except that students did not prefer the group assignment method, which can help develop an attitude towards statistics as confirmed by Donohue and Richards (2009), and moreover students preferred the real life examples to help them understand a given statistical concept as found by a research done by García-Santillán et al. (2014).

Preferred Teaching Style Used by the Authors was Satisfactory for all the Students Before and After the Test

As far as the inferential statistics is concerned, the authors found that the students' persuasions and preferences regarding statistics, intellectual techniques and educating techniques have altered between the beginning and the conclusion of the module.

However, students reported a lack of confidence in statistics as confirmed in a research done by Sulieman (2015); it was also found by the research done by Slootmaeckers et al. (2014) which was confirmed by Hagen et al. (2013), Williams (2014), Förster and Maur (2015) that students were feeling even more scared of the course as compared to the initial level of fear as it was found.

Students also reported saying that statistics is the most difficult course and that conception

went a bit higher as compared to the initial level as confirmed by a study done by Hannigan et al. (2014) and Jatnika (2015). Students reported that the fact of considering themselves as not being intelligent enough helps to build up an attitude towards statistics as confirmed by a study done by Kristi (2013) at Clayton State University and a paper published by Ngirande and Mutodi (2014). Students reported that group assignments are unfair, as they do not help to focus and solve the problems individually; this been confirmed by Ladley et al. (2015).

Lastly, students reveal that real life examples help understand statistics concepts, results that are confirmed by Mvududu and Kanyongo (2011) and David et al. (2013).

CONCLUSION

Several results have come out of both the pre-module and the post-module investigations. Mainly, considering that both the authors' awareness and anecdotal report indicated that learners' degrees of fright and nervousness about enrolling for a statistics module can be relatively excessive, the authors were shocked to discover that students originally delineated a poor grade of fright and nervousness (an average grade of 2.89, which is below 3.0 on a scale of 1 to 5). The reason for this could be that the students who enrolled for the module had learned from preceding students (who had formerly enrolled for the statistics module) and declared that the module was indeed not horrifying and was conceived in a way to maximize learners' expectation of passing, the extra evening classes and intensive tutorial sessions (organized by the authors in previous years) have also played an urgent role because they helped expose students to statistical concepts and afforded them opportunities to solve past questions.

Although students outlined poor degrees of fright and nervousness prior to the module, surprisingly the authors discovered that students' degrees of fright and nervousness about statistics increased roughly by an average grade of 11 percent (founded on the five queries that rated the component of fright and nervousness about statistics module) by the conclusion of the module to an expected grade of 3.21 on a scale of 1 to 5.

RECOMMENDATIONS

However, it is hard to deduce the exact isolated aspects of the manner we admitted that pedagogy of our statistics module might possibly be adding values to the fall-down in learners' degree of fright and nervousness. The researcher believes that they have the obligation of inserting many propositions and new ideas into the criticism of the science statistics modules' anecdotal literature on statistical pedagogy at the University of Fort Hare. That is, the researchers believe that their combination of using group assignment and non-real life examples may not have contributed to the fundamental decrease in students' fright and nervousness, hence the authors have to revise and adapt the conception and delivery of the course to address the major findings from this study. The introduction of real-life based examples and individual assignments, among others, could help improve students' attitudes towards statistics.

Moreover, from the study, it can be seen that a number of implications have arisen; further in this domain, related investigation is required. Pending the time additional investigations are carried out on the pedagogy and philosophy of lecturing statistics to Bachelor of Science learners, science educators face the danger of maintaining teaching confirmation grounded science application without confirmed ground of proof. Consequently, the researchers hope that the findings of this investigation will start to assist in filling in the cavity of proof and motivating more science instructors and assessors to undertake and produce their own supplementary findings.

Moreover, it has been noticed that students look to desire and perceive some intellect and educating techniques, uncommonly the one that incorporates visual supports, real life illustrations- and educators who are friendly. Furthermore, the research proposes that while students can begin statistics modules with distinct degrees of fright and nervousness, effective use of their preferred intellectual and educating styles can seriously minimize the student's fright and nervousness.

LIMITATIONS

This investigation has a number of possible limitations which are important to emphasize. The investigation used a relatively restricted num-

ber of entrants (109) in one specific academic outline and in one specific university. Hence, the findings from this specific sample of Bachelor of Science students may not be typical of Bachelor of Science students for some other programs in other universities or institutions.

Furthermore, the restrictions of the investigation model make the survey open to a number of hazards of internal validity. To illustrate this, the absence of arbitrary selection of correspondents (randomization) and the use of a control group of correspondents make it strenuous to explain the variations between pre- and post-test grades in the sample.

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