Analysis of *World Camp* HIV/AIDS Quizzes

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May 3, 2004

Contents:

Appendices are available on enclosed "wck_stat" CD-ROM.

1. Introduction:

World Camp for Kids (WC) is a Non-Governmental Organization operated by current college students and recent graduates. The organization began four years ago. During the summer of 2000, two UNC-Chapel Hill students visited schools and ministries of education throughout southern Africa. They established contacts and evaluated specific country and regional needs. They also researched effective teaching methods, raised funds, and developed a curriculum. Volunteers were then recruited from universities across the country. In the summer of 2001, this team conducted educational day camps in South Africa, Botswana, Zambia, and Malawi. Since then WC has grown immensely. WC is now able to reach thousands of children every year through the efforts of nearly forty volunteers from the US and UK. The group operates with several vehicles out of a headquarters in Lilongwe, Malawi. This summer the group will conduct about thirty camps at primary schools and street shelters in the rural areas surrounding Lilongwe. Volunteers will teach about HIV/AIDS, environmental conservation, and nutrition, as they have the past four summers.

Nearly twenty percent of adults Malawians are HIV positive. Accordingly, HIV/AIDS education is integral to WC's program. WC volunteers spend a majority of their classroom time teaching about HIV/AIDS. The WC HIV/AIDS curriculum involves ten primary aspects. WC volunteers address the contagious nature of HIV/AIDS throughout its' infection course. Volunteers explain basic HIV pathology and progression to AIDS. HIV transmission and prevention is addressed, leading to a discussion of latex condoms. Students have the opportunity to ask anonymous questions in the context of a sex separated dialogue concerning sexual intercourse, HIV/AIDS, and communication between sexual partners. To foster long-term community HIV/AIDS prevention, camps conclude with student HIV/AIDS presentations for the public. The presentations are well attended by villagers. Also, students and teachers are urged to form extracurricular HIV/AIDS clubs. See Table 1.1 for further information.

1.)	One cannot tell if a person has HIV by looking at him or her.
2.)	Basic HIV pathology.
3.)	HIV progression to AIDS.
4.)	HIV Transmission: sexual intercourse, blood-to-blood contact, and mother-to-child.
5.)	HIV transmission in a population.
6.)	The *ABC*'s of Prevention: *A*bstinence, *B*eing Faithful, and *C*overing Up.
7.)	Latex condoms.
8.)	Negotiating the terms of sexual intercourse.
9.)	Anonymous student questions.
10.)	Community outreach during after educational camps.

Table 1.1 – HIV/AIDS Curriculum Primary Topics

Most topics are addressed by lectures supplemented with visual aids in the classroom. Educational games reinforce comprehension of difficult subjects. Negotiating the terms of sexual intercourse requires the separation of male and female students. Frank, honest discussions ensue. The lecture material, teacher comments, and a quiz are translated to Chichewa, Malawi's predominant native language. When appropriate, student input is translated to English.

The quiz was devised to quantify student comprehension. Its nine questions focus on the lecture material. Each question has one correct answer which the student must circle. Answer choices are *Yes*, *No*, and *Maybe*. The quiz is administered at the start and conclusion of each camp. When possible, a third quiz is administered several weeks later. Performance on the quiz is a measure of both student comprehension and WC's effectiveness. See Table 1.2 for the exact quiz format and correct answers.

1.)	Can you tell if a person has AIDS by looking at him or her?	Yes	Maybe	No
2.)	Is there a difference between HIV and AIDS?	Yes	Maybe	No
3.)	Can people get HIV/AIDS through sex?	Yes	Maybe	No
4.)	Can small children get HIV/AIDS though sex?	Yes	Maybe	No
5.)	Can you get HIV/AIDS if you have unprotected sex once?	Yes	Maybe	No
6.)	Can a mother give her child HIV/AIDS through breast milk?	Yes	Maybe	No
7.)	Is HIV/AIDS a problem only in Africa?	Yes	Maybe	No
8.)	Is it better to wear more than one condom?	Yes	Maybe	No
9.)	What must be on toothbrushes, razors, and needles to spread HIV?	Blood	Sweat	Saliva

Table 1.2 – HIV/AIDS Quiz Format (English). Correct answers are highlighted with red.

Almost two thousand quizzes were given during the late summer of 2003. Several hundred were disqualified from analysis due to student or teacher labeling mistakes, leaving 1687 quizzes for study. Demographic data was relatively constant through the three series of quizzes given. Due to disproportionate school attendance, more males took the quiz in every standard (Std.). Due to the WC program constraints, more Std. 8 than Std. 7 students completed the quiz. Also, more Std. 7 than Std. 6 students completed the quiz. See Chart 1 for a more detailed analysis of demographic data.

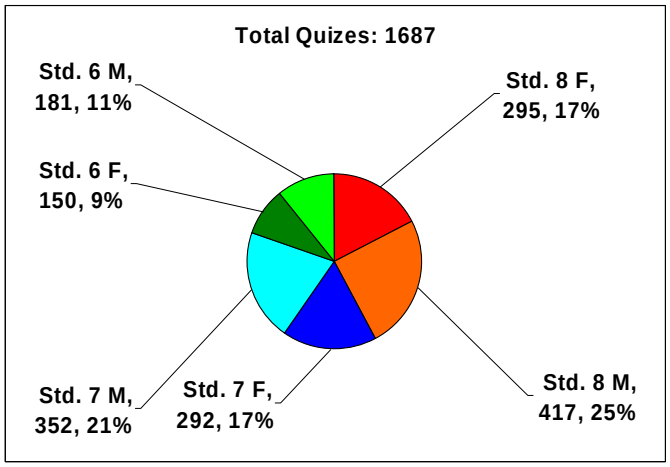

Chart 1 – Quiz Demographic Data.

2. Procedure:

2.1 Data Sampling.

Before addressing any lecture material, WC volunteers administer the first HIV/AIDS quiz in an identical series of three. After WC Volunteers arrive at their campsite, typically a rural primary school, they spend approximately an hour getting to know their students outside of the classroom. Translators are frequently utilized in this process and throughout the camp's duration. At approximately 9 AM, WC volunteers take their students into classrooms. A pair of volunteers is assigned 20 – 40 students by WC directors or school officials.

While the students are seated, volunteers pass the quiz to each student in the room. Through a translator, they are told to write their sex, age, standard, school name, and the numeral *1* on the quiz's reverse side. The quizzes are given anonymously. Volunteers emphasize that no names are recorded, that the students' usual instructors will not evaluate the quiz, and that the quiz is a measure of WC's effectiveness. Volunteers and translators work patiently with students to ensure correct quiz labeling. Once all student papers are labeled, volunteers and translators read the questions aloud. After a question is read, the students are asked to circle the one correct answer adjacent to it. During the quiz, students are urged not to speak or look at other students' papers. Once the nine questions have been answered,

the quizzes are promptly taken up. They are placed in a supply box, and returned to WC headquarters at the day's end.

Just before leaving the camp, WC volunteers and translators administer the second quiz. The quiz format is identical to the first. WC volunteers and translators follow a similar procedure in giving the second quiz. However students are asked to label their papers with the numeral *2*, as opposed to the numeral *1*. Also, students who failed to attend all WC HIV/AIDS lectures are asked to refrain from taking the second quiz. The third quiz is given 4 – 6 weeks after the second at a prescheduled time during a regular school day by WC volunteers and translators. The quiz format and testing environment are identical to the first two with appropriate labeling changes. The quiz is given to students who presumably took the first and second quizzes.

2.2 Data Analysis.

2.2.1 Quiz Groups and Subgroups.

Each quiz is examined for proper labeling. It must include the student's sex, Std., school name, and series number. Of nearly two thousand quizzes administered in the late summer of 2003, several hundred were disqualified from analysis due to improper labeling. A total of 1687 are available for study. The quizzes are divided into subgroups according to their label. Quizzes are first separated by series number, and in turn by sex, Std., and school name. *Quiz 2, Female, Std. 7, Matunduluzi School* is a representative subgroup of quizzes. Quizzes from each subgroup are graded. Responses for each question are recorded. Students are awarded 1 point for each correct answer and 0 points for each incorrect answer. Responses for each question and each student's total are averaged over the number of students in the subgroup. Means are then renormalized to percentage points. See table 2.2.1 for the grade data of a typical subgroup. Data from each subgroup is combined to attain information concerning larger groups of students. Groups are limited to data within a quiz series. A group may contain all students from a given school, given standard, given sex, or given quiz series number. See appendix B to view data from all available groups. Meaningful comparisons are drawn from analyzing the performance of a group or subgroup in a given quiz series with respect to that same group's or subgroup's performance on a different quiz. Most obviously, the mean score of all students on the first quiz is compared to the mean score of all students on the second and third quizzes. Comparisons of different groups' performances within the same quiz are also of interest. For instance, the male's scores may be contrasted with the female's scores in each quiz series.

Quiz 2													
				Question #:	1	2	3	4	5	6	7	8	9
Sex:	Standard:	F.P. School:		Points:									
F	7	Matunduluzi			1	0	1	1	1	1	1	1	1
F	7	Matunduluzi			1	0	0	1	1	1	1	0	1
F	7	Matunduluzi			1	1	1	1	1	1	1	1	1
F	7	Matunduluzi			1	0	1	1	1	1	1	0	1
F	7	Matunduluzi			1	1	1	1	1	1	1	1	1
F	7	Matunduluzi			1	0	1	1	1	1	1	1	0
F	7	Matunduluzi			1	1	1	1	1	1	1	0	1
F	7	Matunduluzi			1	1	1	1	1	1	1	0	1
F	7	Matunduluzi			1	1	1	1	1	1	1	1	1
			Total:		9	5	8	9	9	9	9	5	8
			Normalized Total:		1	0.56	0.89	1	1	1	1	0.56	0.89
			Mean %:		87.7								

Table 2.2.1 – Grade Data from a Representative Subgroup.

2.2.2 Statistical Objectives and the Chi Square test. [1]

WC seeks to understand the relationship between the performance of different student groups on the HIV/AIDS quiz and progression through the quiz series in a statistically rigorous context. The mean score achieved by a student group on a given quiz is of interest. However, the trend of student responses to a given question through the quiz series, coupled with the statistical significance of the trend is more meaningful. Due to its simplicity and assumptions regarding data type, the Chi Square test for independence was chosen in accord with WC's statistical objectives. The Chi Square test for independence, also known as Pearson's Chi Square Test, is a straightforward procedure for determining the association between rows and columns of tabular data. Chi Square tests are utilized for random, independent, and discreet data sets. WC HIV/AIDS quiz data is random: all correctly labeled quizzes through the quiz series are accepted for study. It is independent: a student's performance on a given quiz is not inherently linked to another student's performance. It is discreet: specifically, correct and incorrect responses to a single question. Assumptions concerning the size of the tested data set and minimum cell frequencies are also met by the WC HIV/AIDS quizzes.

As is common in significance testing, Chi Square analysis involves assessing a *Null Hypothesis* of data independence. The *Null Hypothesis* states, "the value in a cell of a bivariate table is independent of its position in that table." Chi Square (χ^2) is the measure of difference between the observed cell values and theoretically expected cell values in an independent situation (E_{ij}). χ^2 is calculated with Equation 2.2.2.1. E_{ij} is calculated with Equation 2.2.2.2.

$$\chi^2 = \sum_i \sum_j \frac{(E_{ij} - O_{ij})^2}{E_{ij}}$$

Equation 2.2.2.1 – O_{ij} is the observed frequency in the bivariate table cell with respect to the indices *i* and *j*. E_{ij} is the expected frequency in the same cell, as defined by Equation 2.2.2.2 below.

$$E_{ij} = \frac{T_i \cdot T_j}{N}$$

Equation 2.2.2.2 – Here, T_i is the total of the *i*th row of the bivariate table, T_j is the total of the *j*th column, and *N* is the total number of sampled data.

A large difference from the theoretically independent situation implies a statistically significant relationship between the rows and columns of tabular data. A low level of difference from the theoretically independent scenario implies a statistically insignificant relationship between the rows and columns. The level of statistical significance is determined by numerically integrating the Chi Square probability density function from the calculated χ^2 to *infinity*. See Equation 2.2.2.3 for the probability density function's exact form. χ^2 and the degrees of freedom (*df*) computed from the data table, respectively form the lower limit and parameterize the indefinite integral. Evaluating the indefinite integral yields *p*, a value used to verify statistical significance. The conventional standard for statistical significance is a *p*-value less than or equal to 0.05. If, for a given χ^2 and *df*, *p* is less than or equal to 0.05, the *Null Hypothesis* is rejected. If *p* is greater than 0.05, the *Null Hypothesis* is accepted. Figures 2.2.2.1 and 2.2.2.2 illustrate the form of the function with one and two degrees of freedom, the conditions under which *p* was calculated during Chi Square analysis.

[1] General formulas in section 2.2.2 are taken from: Hayes, William. *Statistics for the Social Sciences*. Holt: New York, 1973. Plots are generated by the *Statistics`ContinuousDistributions`* package of *MATHEMATICA.*

$$f(x) = \frac{e^{-\frac{x}{2}} \cdot x^{\frac{\nu}{2}-1}}{2^{\frac{\nu}{2}} \cdot \Gamma(\frac{\nu}{2})}, \text{ for } x \le 0.$$

Equation 2.2.2.3 – The general probability density for the Chi Square Distribution. ν are the degrees of freedom and *x* represents the χ^2 variable. Γ is the gamma function.

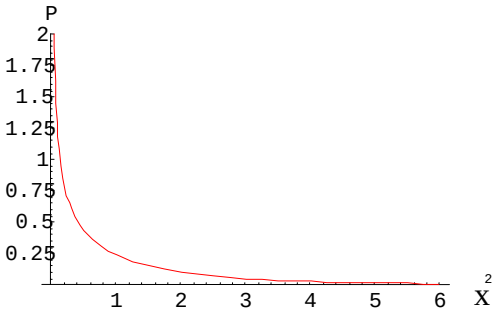

Figure 2.2.2.1 – The χ^2 probability density function with $\nu = 1$ over a typical domain.

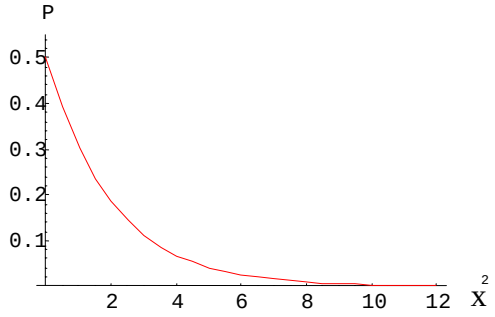

Figure 2.2.2.2 – The χ^2 probability density function with $\nu = 2$ over a typical domain.

2.2.3 Annotated Sample Calculation.[2]

In this section, data regarding total student performance on question 1 of the HI/AIDS quiz is tested for independence by Chi Square analysis. Calculations are annotated to enhance reader comprehension of the analysis procedure. The sample *Null Hypothesis* is simply: "a given value in a 2 x 3 bivariate table is independent of its position in that table." For the sample calculation, rejection of the *Null Hypothesis* implies the number of correct and incorrect answers is dependent on progression through the quiz series. Data is arranged such that responses from quiz 1, quiz 2, quiz 3, and a summation over the data form the table's four rows. The number of correct, incorrect, and total responses comprise the table's three columns. As is conventional, the data set constructed from these stipulations is regarded as a 2 x 3 table. Totals are not considered in the row and column count. Specific data arrangement is illustrated in Table 2.2.3.

#1			
	correct	incorrect	total
quiz 1	237	376	613
quiz 2	447	87	534
quiz 3	417	123	540
total	1101	586	1687

Table 2.2.3 – Data regarding all student's performance on question 1 in a standard 2 x 3 bivariate table.

Once the data has been appropriately organized, a preliminary value must be obtained before the χ^2 of the data set can be calculated. The expected response frequency for each cell of the table, E_{ij}, where *i* is the row number and *j* the column number, for an independent scenario must be obtained. In this example, the E_{ij} represent the expected number of correct or incorrect responses in a cell, as defined by the *i* and *j* indices, if the respective response was independent of progression through the quiz

[2] Calculations in section 2.2.3 are performed with *MATHEMATICA* utilizing the *Statistics`ContinuousDistributions`* package where appropriate.

series. To ascertain E_{ij}, Equation 2.2.2.2 is employed. From Equation 2.2.2.2, it is easy to see that $E_{11} = \frac{613 \cdot 1101}{1687} = 400.067$. The remaining E_{ij} are calculated in the same manner.

$$E_{12} = \frac{613 \cdot 586}{1687} = 212.933$$
$$E_{21} = \frac{534 \cdot 1101}{1687} = 348.509$$
$$E_{22} = \frac{534 \cdot 586}{1687} = 185.491$$
$$E_{31} = \frac{540 \cdot 1101}{1687} = 352.424$$
$$E_{32} = \frac{540 \cdot 586}{1687} = 187.576$$

χ^2 is directly obtainable after each E_{ij} has been calculated. Utilizing Equation 2.2.2.1, it follows $\chi^2 = 305.54$ for all student responses to question 1. Calculation details are displayed below.

$$\chi^2 = \frac{(E_{11} - O_{11})^2}{E_{11}} + \frac{(E_{12} - O_{12})^2}{E_{12}} + \frac{(E_{21} - O_{21})^2}{E_{21}} + \frac{(E_{22} - O_{22})^2}{E_{22}} + \frac{(E_{31} - O_{31})^2}{E_{31}} + \frac{(E_{32} - O_{32})^2}{E_{32}},$$
$$\chi^2 = \frac{400.067 - 237}{400.067} + \frac{212.993 - 376}{212.993} + \frac{348.509 - 447}{348.509} + \frac{185.491 - 87}{185.491} + \frac{352.424 - 417}{352.424} + \frac{187.576 - 123}{187.576},$$
$$\chi^2 = 305.54$$

The standard expression $df = (R-1) \cdot (C-1)$, where is *R* the number of bivariate table rows and *C* the number of columns, indicates the system has $(3-1) \cdot (2-1) = 2$ degrees of freedom, or *df*.
The general probability density function for a squared random variable *x* with ν degrees of freedom is displayed in equation 2.2.2.3. For $df = \nu = 2$, the Equation 2.2.2.3 simplifies to $f(x) = \frac{e^{-\frac{x}{2}}}{2}$. Numerical integration of the equation from the determined value of χ^2 to *infinity* yields the *p*-value, the probability that the data is independent. Visual inspection of the exponentially decaying function indicates the p-value will be extremely low for $\chi^2 = 305.54$. For the abscissa χ^2 = 305.54, the ordinate *p*, is approximately 10^{-67}. The function is plotted on a scale appropriate to the calculated χ^2 in Figure 2.2.3.

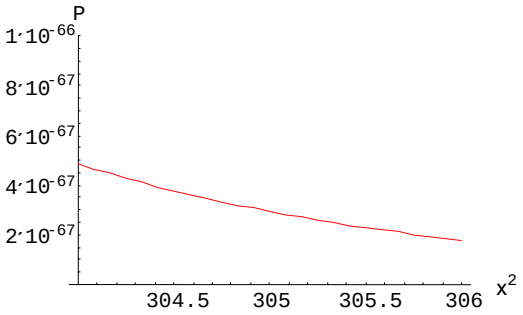

Figure 2.2.3 – The χ^2 probability density function plotted in the region surrounding the calculated χ^2.

Not surprisingly, integration of the function defined by $df = \nu = 2$ from χ^2 = 305.54 to *infinity* gives a *p*-value of 5.89 x 10^{-67}. Thus, the probability of the data in the bivariate table being independent is exceedingly small. The *Null Hypothesis* is rejected, and the correlation between student response and quiz series is deemed statistically significant.

3. Results:

3.1 Quiz 1 Results

The 613 students who completed quiz 1 scored on average 6.15 out of 9 points, or 68 %. Questions 1, 2, and 8 were missed most, followed closely by question 4. Questions 1, 2, and 8 were missed by 60% of the students. Question 4 was missed by 40% of the students. Question 3 was answered correctly by nearly all students. Question 9 was answered correctly by 90% of the students. The 273 females who completed quiz 1 scored an average 6.06 out of 9 points, or 67%. Questions 1 and 8 were missed by 60% of female students. Question 2 was missed by 70%. Questions 3, 5, 7, and 9 were answered correctly by 90% – 100% of females. The 340 males who completed quiz 1 scored an average 6.21 out of 9 points, or 69%. Questions 1 and 8 were answered incorrectly by 60% of males. Question 2 was answered incorrectly by 50% of males. Question 4 was answered incorrectly by 40%. Questions 5, 7, and 9 were answered correctly by 90% of males. Almost all males answered question 3 correctly. The 248 Std. 8 students who finished quiz 1 scored on average 6.27 out of 9 points, or 70%. Questions 1, 2, and 8 were missed by half or more Std. 8 students. Questions 3, 5, 7 and 9 were answered correctly by nearly all Std. 8 students. The 245 Std. 7 students who completed quiz 1 scored on average 6.23 out of 9 points, or 69%. Questions 1, 2, and 8 were missed by 50% – 60% of Std. 7 students. Almost all Std. 7 students answered questions 3, 7, and 9 correctly. The 120 Std. 6 students who completed quiz 1 scored on average 5.72 out of 9 points, or 64%. Questions 1, 2 and 8 were answered incorrectly by 70% – 80% of Std. 6 students. Questions 3, 7 and 9 were answered correctly by 90% – 100% Std. 6 students. More detailed grade data for quiz 1 is presented in Appendix B.1. See Table 3.1 for a summary of quiz 1 grade data.

Demographic	Mean (%)	Most Incorrect	% Incorrect	Most Correct	% Correct
All	68	Q. 1, 2, and 8	60	Q 3,5,7, and 9	90 - 100
Females	67	Q. 1, 2, and 8	60 - 70	Q 3,5,7, and 9	90 - 100
Males	69	Q. 1, 2, and 8	50 - 60	Q 3,5,7, and 9	90 - 100
Std. 8	70	Q. 1, 2, and 8	50 - 60	Q 3,5,7, and 9	90 -100
Std. 7	69	Q. 1, 2, and 8	50 - 60	Q 3,5,7, and 9	80 - 100
Std. 6	64	Q. 1, 2, and 8	70 - 80	Q 3,5,7, and 9	80 - 100

Table 3.1 - Quiz 1 Grade Data Summary. Here and in Tables 2.2 and 2.3, question is abbreviated as *Q*. The column *Most Incorrect* indicates which questions were answered incorrectly most often by students. The *% Incorrect* column lists the rough percentage of students who answered these questions incorrectly.

The next two columns, *Most Correct* and *% Correct*, address the analogous data for questions answered correctly.

3.2 Quiz 2 Results

The 534 students who completed quiz 2 scored on average 7.71 out of 9 points, or 86%. Questions 2 and 8 were missed most. Question 2 was missed by 40% of the students. Question 8 was missed by 30% of students. Questions 3 and 9 were answered correctly by 100% of the students. Questions 5, 6, and 7 were answered correctly by 90% of the students. The 230 females who completed quiz 2 scored an average 7.63 out of 9 points, or 85%. Question 2 was missed by 40% of females. Question 8 was missed by 30% of females. A majority of the other questions were answered correctly by 90% – 100% of females. The 304 males who completed quiz 2 scored an average 7.77 out of 9 points, or 86%. Question 2 was answered incorrectly by 30% of males. Question 2 was answered incorrectly by 30% of males. Most other questions were answered correctly by 80% – 100% of males. The 226 Std. 8 students who finished quiz 2 scored on average 7.91 out of 9 points, or 88%. Question 2 was missed by 30% of Std. 8 students. All other questions were answered correctly by 80% – 100% of Std. 8 students. The 207 Std. 7 students who finished quiz 2 scored on average 7.80 out of 9 points, or 87%. Question 2 was missed by 40% of Std. 7 students. Other questions answered correctly by 80% – 100% of Std. 7 students. The 101 Std. 6 students who finished quiz 2 scored on average 7.25 out of 9 points, or 81%. Half of Std. 6 students missed question 2. Question 8 was missed by 40% of Std. 6 students. A small majority of other questions were answered correctly 90% – 100% of Std. 6 students. More information concerning Quiz 2 grade data is available in Appendix B.2. See Table 3.2 for a summary of quiz 2 grade data.

Demographic:	Mean (%)	Most Incorrect	% Incorrect	Most Correct	% Correct
All	86	Q. 2 and 8	30 - 40	Q. 3,5,6,7, and 9	90 - 100
Females	85	Q. 2 and 8	30 - 40	Q. 1,3,5,6,7, and 9	90 - 100
Males	86	Q. 2	30	Q. 3,5,6,7, and 9	90 - 100
Std. 8	88	Q. 2	30	Q. 1,3,5,6,7, and 9	90 - 100
Std. 7	87	Q. 2	40	Q. 3,5,6,7, and 9	90 - 100
Std. 6	81	Q. 2	40 - 50	Q. 3,5,6,7, and 9	90 - 100

Table 3.2 - Quiz 2 Grade Data Summary.

3.3 Quiz 3 Results

The 540 students who completed quiz 3 scored on average 7.47 out of 9 points, or 83%. Questions 2 and 8 were missed most. Both were missed by nearly 40% of the students. Questions 3 and 9 were answered correctly by almost every student. Questions 5, 6, and 7 were answered correctly by approximately 90% of the students. The 234 females who completed quiz 3 scored an average 7.33 out of 9 points, or 81%. Nearly 40% of females answered questions 2 and 8 incorrectly. Roughly 30% answered question 4 incorrectly. Most of the other questions were answered correctly by 80 – 100% of females. The 306 males who completed quiz 3 scored an average 7.58 out of 9 points, or 84%. Questions 1 and 8 were missed by approximately 30% of males. Questions 2 and 8 were missed by 30% of males. All other questions were answered correctly by 80% – 100% of males. The 238 Std. 8 students who completed quiz 3 scored on average 7.66 out of 9 points, or 85%. Questions 2 and 4 were answered incorrectly by 30% of Std. 8 students. Question 8 was missed by 40%. The other questions were answered correctly by 90% – 100% of Std. 8 students. The 190 Std. 7 students who completed quiz 3 scored on average 7.72 out of 9 points, or 86%. Question 2 was missed by 40% of students. Question 8 was missed by 30%. The other questions were answered correctly by 80% – 100% of Std. 7 students. The 112 Std. 6 students who completed quiz 3 scored on average 6.91 out of 9 points, or 77%. Questions 1 and 2 were answered incorrectly by 50% of Std. 6 students. Question 8 by was missed by 40% of students, questions 2 and 4 by 30%. The remaining questions were answered correctly by 90% of Std. 6 students. Detailed quiz 3 grade data is available in Appendix B.3. See Table 3.3 for a summary of Quiz 1 grade data.

Demographic:	Mean (%)	Most Incorrect	% Incorrect	Most Correct	% Correct
All	83	Q. 2,4, and 8	30 - 40	Q. 3,5,6,7, and 9	90 - 100
Females	81	Q. 2,4, and 8	30 - 40	Q. 3,5,6,7, and 9	90 - 100
Males	84	Q. 2 and 8	30	Q. 3,5,6,7, and 9	90 - 100
Std. 8	85	Q. 2,4, and 8	30 - 40	Q. 1,3,5,6,7, and 9	90 - 100
Std. 7	86	Q. 8	30	Q. 3,5,6,7, and 9	90 - 100
Std. 6	77	Q. 1,2 and 8	40 - 50	Q. 3,5,6,7, and 9	90

Table 3.3 - Quiz 3 Grade Data Summary.

3.4 Significant Trends

For all students, the mean score increased from 68% on quiz 1 to 86% on quiz 2. Scores decreased from 86% to 83% on quiz 3. See Chart 3.4.1.

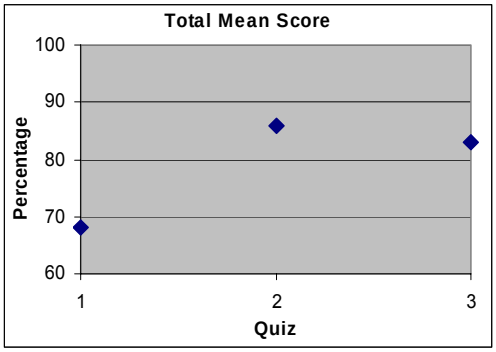

Figure 3.4.1 – Average Grade Trends, all students.

The increase in mean scores is not necessarily statistically significant. However, it is derived from significant data, and assumed be a straightforward manner of illustrating significant grade trends. Question 3 was answered correctly by 90% – 100% of students throughout the quiz series. Data from question 3 yields a Chi Square of 3.2. In a system containing 2 degrees of freedom, this Chi Square corresponds to a *p*-value of 0.2018. All subsequent *p*-values are calculated with two degrees of freedom, unless described otherwise. Thus, the number of correct answers for question 3 does not increase significantly. Data indicating an increase in correct answers for each question from quiz 1 to the later quizzes is significant except for question 3. Chi Square values for the remaining questions vary from 9.7 to 305.5. The *p*-value of question 7 is 0.0077. All other questions give p-values less than 0.0001. Table 3.4.1 contains specific Chi Square and *p*-value information from all students' responses to each question.

Q.	1	2	3	4	5	6	7	8	9
χ^2	305.539	67.4747	3.2007	57.476	35.5891	163.649	9.72341	134.252	21.7206
p	<0.0001	<0.0001	0.2018	<0.0001	<0.0001	<0.0001	0.0077	<0.0001	<0.0001

Table 3.4.1 – Chi Square and *p*-value Data, all students.

Females scored a mean of 67% on the first quiz, 85% on the second, and 81% on third. Males scored an average of 69% on the first quiz, an average of 86% on the second, and an average of 84% on the third. Chart 3.4.2 is a visualization of the average scores for females and males through the quiz series. Once again, the increase in mean scores is not necessarily a significant trend, but it is derived from the parallel significant trend in each question. Though females consistently scored lower than males on the three quizzes, this trend is not significant. Preliminary calculations give low Chi Square values and insignificant *p*-values.

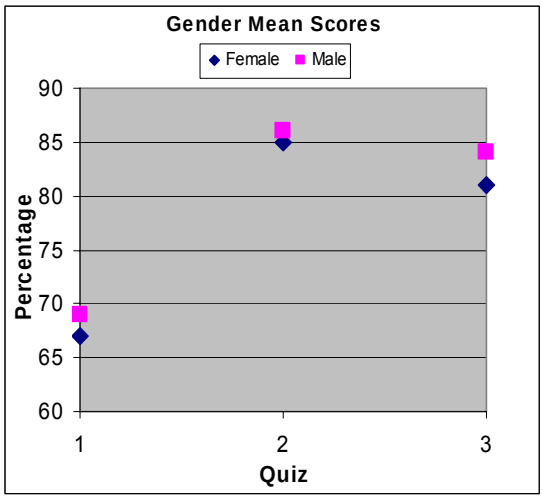

Figure 3.4.2 – Average Grade Trends, by gender.

Like the grades of all students, the increase of correct answers on question 3 is not significant for females or males. Almost all females and males throughout the quiz series answer question three correctly. The Chi Square for question 3 utilizing female grade data is 2.0, corresponding to a *p*-value of 0.3615. For question 3, Male grade data yields a Chi Square of 1.3 and a *p*-value of 0.5109. Question 7 data also exhibits an insignificant increase for Males. When calculated with male data, the Chi Square for question 7 is 4.0152 and the *p*-value, 0.1343. Not surprisingly, 90% – 100% of males answered question 7 correctly through all three quizzes. Female Chi Square values range from 6.1 to 168.9 for the remaining questions, corresponding to *p*-values between 0.0462 and less than 0.0001. Male grade data gives Chi Square values from 13.5 to 145.4 and *p*-values from 0.0011 to less than 0.0001. Accordingly, the increase in correct answers on the majority of questions proceeding through the quiz series is significant. Table 3.4.2 presents additional Chi Square and *p*-value data from female and male responses to each quiz question.

Q.	1	2	3	4	5	6	7	8	9
female:									
χ^2	168.85	41.976	2.0348	18.129	25.131	67.718	6.1485	57.867	7.2186
p	<0.0001	<0.0001	0.3615	0.0001	<0.0001	<0.0001	0.0462	<0.0001	0.0271
male:									
χ^2	145.45	27.127	1.3433	41.036	13.544	96.466	4.0152	76.236	15.151
p	<0.0001	<0.0001	0.5109	<0.0001	0.0011	<0.0001	0.1343	<0.0001	0.0005

Table 3.4.2 – Chi Square and *p*-value Data, by sex.

Std. 8 students scored an average of 70% on quiz 1, 88% on quiz 2, and 85% on quiz 3. Std. 7 students scored an average of 69% on quiz 1, 87% on quiz 2, and 86% on quiz 3. Std. 6 students scored a mean of 64% on quiz 1, 81% on quiz 2, 77% on quiz 3. Again, these averages are discussed simply to display grade trends. See Chart 3.4.3 for further illustration.

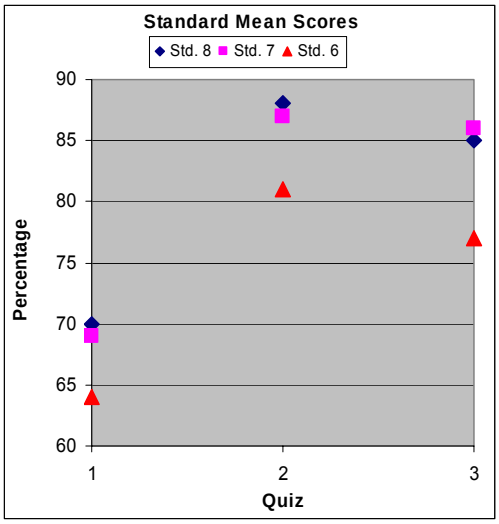

Figure 3.4.3 – Average Grade Trends, by standard.

For Std. 8 students, the increase in correct answers through the quiz series is statistically significant for the majority of questions. Decreased sample size may influence the data interpretation. However, the insignificant increase in correct answers to questions 3, 5, 7, and 9 for Std. 8 students ultimately arises from their performance on these questions. Questions 3, 5, 7, and 9 were answered correctly by 90% - 100% of Std 8 students on all quizzes. Data from these questions give Chi Square values ranging from 0.42348 to 4.51862 and *p*-values from 0.80920 to 0.1044.The increasing trend in the remaining questions is statistically significant. Chi Square for the remaining questions varies from 24.3 to 178.1. These Chi Square values correspond to *p*-values less than 0.0001. For 8 of 9 questions, the increase in correct answers by Std. 7 students is statistically significant. Chi Square for question 3 is 2.9, corresponding to a p-value of 0.2372. The increase in correct answers for question 3 is insignificant for reasons previously discussed in detail. The increase in correct answers for the remaining questions is significant. Calculations yield Chi Squares from 6.5 to 93.8, and *p*-values from 0.0391 to less than 0.0001. For Std. 6 students, the number of correct answers to most questions increased significantly through the quiz series. Calculations utilizing data from questions 3, 4, and 7 give insignificant results. Chi Squares are 0.1, 2.2, and 2.4, and *p*-values 0.9111, 0.3373, and 0.2948 respectively. Chi Square for the remaining questions range from 7.6 to 55.1, and *p*-values from 0.0227 to less than 0.0001. For specific Chi Square and *p*-values calculated by Std., see Table 3.4.3 below.

Q.	1	2	3	4	5	6	7	8	9
Std. 8:									
χ^2	178.105	27.9054	1.50623	24.3255	4.51862	71.2425	0.42348	37.9807	1.23834
p	<0.0001	<0.0001	0.4709	<0.0001	0.1044	<0.0001	0.8092	<0.0001	0.5384
Std. 7:									
χ^2	93.7788	18.9816	2.8775	34.3478	20.2585	54.222	6.48493	75.4737	16.6523
p	<0.0001	<0.0001	0.2372	<0.0001	<0.0001	<0.0001	0.0391	<0.0001	0.0002
Std. 6:									
χ^2	55.1386	20.454	0.18623	2.17333	7.5739	30.4145	2.44261	20.68	8.59833
p	<0.0001	<0.0001	0.9111	0.3373	0.0227	<0.0001	0.2948	<0.0001	0.0136

Table 3.4.3 – Chi Square and *p*-value Data, by standard.

When calculated in steps, from quiz 1 to quiz 2, and from quiz 2 to quiz 3, the score increase from quiz 1 to quiz 2 is typically statistically significant, while the small decrease in scores is typically statistically insignificant. This effect is especially pronounced when calculated by Std. For all students, the increase in correct responses from quiz 1 to quiz 2 is significant for all questions, but question 3. The decrease in correct responses is significant for questions 1,6, and 8. For Std. 8 students, the decrease in correct responses is significant only on questions 6 and 8. For Std. 7 students, the decrease is significant solely on question 6. The *p*-value for the decrease on this question by Std. 7 students, calculated with

one degree of freedom, is 0.049. Though Std. 6 students scored lower through the quiz series as compared to the higher standards, the decrease in correct responses for Std. 6 students from quiz 2 to quiz 3 is significant only on questions 1 and 9. See Appendix D for detailed Chi Square and *p*-value data.

4. Conclusion:

Scores improve from quiz 1 to quiz 2, then decrease slightly on quiz 3. The decrease is typically statistically insignificant. Std. 7 and 8 students are basically retaining all improvements in the gap between the second and third quizzes. Thus, most WC students are able to perform well on quiz 2 and replicate this performance on quiz 3. As mentioned earlier, the larger number of correct scores on each question by males throughout the study is not generally statistically significant. However, the female's lower scores are consistent with the educational environment in southeastern Africa. Unfortunately, Std. 6 students are scoring lower on all quizzes than the higher standards. They also appear to retain less information from quiz 2 to quiz 3. Several circumstances may account for the reduced performance of Std.6 students. Std. 6 students are typically less academically experienced and devoted than Std. 7 and 8 students. From the average scores on quiz 1, Std. 7 and 8 students appear to have a greater base of HIV/AIDS knowledge. Also, Malawi's public education system allows only the most devoted and competitive students to reach higher standards. In future sessions, WC volunteers should focus more attention toward the special educational challenges faced by their female and less experienced students.

Further issues influencing the outcome and meaning of this study include student cheating, the decreased number of students taking the second and third quiz, the apparent ease of question 3, and the importance of question 1. Though students are asked not to speak with their neighbors or consult their neighbor's papers, they do both. Cheating certainly affects the number of correct answers on each question all through the quizzes. Cheating should be considered when consulting the results of this study. A smaller number of students take the second and third quizzes, indicating reduced attendance through individual camps. Students who choose to miss later days of the camp most likely consider the WC program a time to catch up on chores or simply hang out with friends outside of school. Future volunteers should urge students to attend all camp days, despite their domestic or social obligations. Question 3 is answered correctly by nearly all students through the quiz series. Therefore, students must understand that HIV is transmitted though sexual intercourse, before and after the WC program. Perhaps the question should be replaced with one more difficult and pertinent. Also, repeatedly questioning of the primary mode of HIV transmission may have undesired pedagogical effects. Through the quiz series, question 1 progresses from answered incorrectly more often, to answered correctly more often. The importance of students comprehending the contagious nature of HIV victims regardless of visible symptoms should not be underestimated. Many students genuinely believe that HIV/AIDS is a visible disease. It is not. After participating in the WC program, students seem to understand this fact. This fact may one day greatly enhance their quality of life, like much of the information WC volunteers share with their students.