What Knowledge Exists about Drinking Water and Academic Achievements in Schools in Ghana, Sierra Leone and South Africa?

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***Abstract*—Knowledge exists about water and its relationship with poverty, health and sanitation, as well as ecological integrity. However, *little knowledge exists about correlation between safe drinking water and academic achievements in schools*. Investigations show little attention on water education in schools, even when international institutions are beating chests about creating and financing principles, declarations and conferences in recognition to importance of water, especially during last two decades in 20th century and first decade into the 21st century. The leading aim of study is to understand knowledge about drinking water and academic achievements in schools in Ghana, Sierra Leone and South Africa. Specific objective is to find out knowledge from students' responses during interviews and test scores at various levels of schooling using chi-square (x^2) and correlation coefficient (r) for analysis. These models are to help establish the relationship between these variables by testing hypotheses to show directions and strengths of these correlations. The data gathering methods include five ways. First, is testing students before sampling and initial instructions without drinking water. Second, testing after drinking water while participating in schooling exercises. The third method uses personal interactions and interviews to gather qualitative data. Fourth, uses psychologies of drinking water during tests and examinations. Last method uses interviews involving psychologists, psychiatrists, medical doctors, nurses, surgeons, physicians and other medical practitioners. Final results are positive with (x^2=7.973>5.991) at 95% level of confidence, as r=0.997, and qualitative analysis show r=0.588, suggesting existence of relationship between drinking water and academic achievements. Results show drinking water improves academic achievements in schools. Respondents are in three countries with different latitudes, locations, climates and ecologies. This study shows how this *high-prize diet* contributes to academic achievements in learners.**

***Index Terms*—Academic achievements, ghana, knowledge, safe drinking water, sierra leone, south africa.**

I. Introduction

"Try to learn something about everything and everything about something"—Thomas Henry Huxley, Biologist (1825-1895).

During elementary school days, late Grandma, Adama Kenyengo (1855-1980), may her soul rest in perfect peace, always applauds people for respecting those that bring water. She usually said *"water is life and those that bring water bring life."* This motivates writing of this piece of knowledge to help create a universal understanding of water as life-sustaining matter, and an academic-improving substance.

Many readings in these areas suggest some importance of water for improving health, reducing poverty, and contributing to economic development. However, literature has long fails to offer large knowledge about safe drinking water and academic achievements among students in schools. However, during my master's academic studies in 2006/2007 at Ghana Institute of Management and Public Administration (GIMPA), students were always having a five-gallon Coleman container of cold and safe drinking water in all classrooms. This water was ready-made by the institution's canteen as part of its hospitality services. The suppliers fail to educate students about needs for safe drinking water for academic achievements. The lady, a primary school graduate serves water in ignorance of her contribution to students' academic achievements as she gladly serves them with safe drinking water.

Many readings show that people know about essential needs for water, but academic literature fall short of knowledge about safe drinking water and academic achievements. Many United Nations agencies, local municipal authorities in countries across the world give water supplies to schools and other institutions of learning. For instance, [1] Pump Industry Analyst (2005) reports about providing potable water to schools in Mozambique to help children learn in healthy environment without clearly educating on importance of water for academic performance. This shows lack of understanding about knowledge of safe drinking water and academic achievements. This study will therefore educate on knowledge about safe drinking water and academic achievements in schools.

II. The Need and Purpose

There is an increasing need to understand knowledge about safe drinking water and academic achievements in schools. As it stands, little ideas exist in studies than passive comments on knowledge about drinking water and academic achievements. Many studies on safe and fresh drinking water focus on environmental integrity, water quality, availability and quantity. Others show value of water in relations to hygiene and sanitation, air quality and health care. Literature on water in general dictates lack of substantial knowledge

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about safe drinking water and academic achievements in schools.

Political, religious, and social descriptions of value of water as mater and supporter of life exist in literature. Yet, little knowledge exists about how this *high-prize diet* contributes to students' academic achievements. Even institutions of higher learning and international institutions like United Nations Educational, Scientific and Cultural Organization show little interest. From here, knowledge about safe drinking water and academic achievements needs this study.

III. Research Setting and Policy Issues

Health and nutrition concerns about safe drinking water are important for school-going children. However, academic achievements are equally or more important as knowledge leads to innovative ideas to offer better health improvements in school-going children. Despite lack of knowledge about safe drinking water and academic achievements, policies and studies on drinking water in general suggest potential threats to school children from school drinking water.

For example, [2] Sathyanarayana, Beaudet, Omri and Karr (2006) prove school-going children can suffer lead concentrations from school drinking water. The study of 71 primary schools however show less than 10 μg/dL suggesting better results for school drinking water. However, this result is on assumptions that *"school drinking water lead concentrations are not significant source of lead exposure in school-age children."* The study shows no exposure greater than one in Environmental Protection Agency Guidelines, and significant exposure sources or water lead concentrations are not higher than those in the study. The argument is suggesting more focus of study involving water, health and hygiene. The study shows importance of health, nutrition and sanitation about school going-age students. It ignores knowledge about safe drinking water and academic achievements in schools.

Further, impact of dehydration on human health can be damaging to academic achievements since a student need to be physically active and healthy to perform in schools. This is true, but fall short of knowledge about drinking water and academic performance. In other words academic achievements improve by water intake. This is through good health, well-being, decrease in obesity, and eventual academic achievements. Other readings suggest need for water availability in schools for student's uses, for helping improve lives of students. The suggestion for uses of drinking water in schools is no doubt a good suggestion. However, lack of an understanding about knowledge of drinking water and academic achievements exists in schools. This lack of ideas suggests ignorance about drinking water and academic achievements.

In addition, [3] Peterson (2008) explains use of writings for offering intellectual knowledge to helps discover more scholarly interdisciplinary reasoning to improve respondents satisfaction from research about impending problems. There is difficulty in understanding diverse locations of important data to mine to inform contributions to larger body of knowledge. The ability to decipher complex data for intellectual apologetics from other disciplines show how study would consume convincing data before offering seemingly simple data service delivery by communicating new knowledge. There is lack of understanding in promoting knowledge about safe drinking water and academic achievements which every parent would equally want for his or her children.

Also, [4] Gardner (2007) shows present-day information overloads producing multipliers of tedious tasks for academicians and other scholars. Knowledge coming from varying sources help enlarge knowledge management difficulties and complexity in interdisciplinary manners. However, blessings from these are researchers need to have energies and needs for interdisciplinary and lifelong learning to foster innovative policy agenda setting, formulation, implementation and evaluation. These policies would help in offering creative theories, models and formulas for resolving research analysis and testing of problems.

A study by [5] Dahar, Faize, Niwaz and Tahira (2010) on deficient use of school resources for academic achievements suggests using two classes of students. Study shows availability of suitable drinking water with academic achievements is insignificant for two types of students—religious and non-religious. It shows some knowledge about water and academic achievements. As it claims all resource inputs including (drinking water) play necessary role in academic achievements. However, study sparingly suggests some form of knowledge about water and academic achievements. It falls short of knowledge about drinking water and academic achievements. The results were negative and insignificant. This suggests little know-how about drinking water and academic achievements in schools.

Moreover, [6] Feller (2007) shows producing knowledge must aim at addressing competing challenges and difficulties that occurs in research agendas needing significant discipline to undo complex psychologies. Indeed, emotional leadership for creating new theoretical underpinnings help resolve many interwoven and interdependencies in modern academic dilemmas. Considering health issues, a study in Bangladesh assesses arsenic contaminations of drinking water from water wells and the effect on children's educational achievements. The study presents a negative impact of contaminations in drinking water on well-being and health status, by influencing educational achievements. The objective is to assess impact of contaminations in water on children's academic achievements. However, it fails to recognize links between drinking water and academic achievements of school-going children as in [7] Asadullah and Chaudhury (2010).

This study indirectly tries to explain there is an association between exposures to contaminations in drinking water, and recommends for policy making to take exposure findings into consideration. The proposals include policy on drinking water to help improve academic achievements in schools. It transfers knowledge by proposing future study should focus on drinking safe water by children from tube wells or alternative safer water resources. This study is therefore essential for offering essential need for an understanding of important role water plays in improving students' academic achievements in schools.

IV. UNDERSTANDING KNOWLEDGE

Knowledge is a store of ideas, thoughts, and facts as well as scenarios and indigenous wisdoms and skills. Knowledge helps in problems-solving for human, societal and economic development. In general, study deals with tacit and explicit knowledge. The innovation skills, thinking, intelligence, and concepts in human heads are tacit. Ailment and death perish tacit knowledge. Tacit knowledge should be open for storages and transfers for impending human uses.

For instance, strategic thinking goes far back as 2000 BC when thinkers like General Sun-Tzu of China suggests applying knowledge transfers during military confrontations. Strategic thinking does not only applies to military and business manoeuvres but help improve academic achievements in schools, and therefore trickles down to national development and regional prosperity.

Explicit knowledge is in some form of information kept for problem-solving. Explicit knowledge can show electronic and non-electronic evidences. The non-electronic forms include hardcopy books, journals, dictionaries and information on billboards and so on. Intelligence can be electronic and hardcopy knowledge in repositories to help in problem-solving.

Wadan (2005) [8] shows innovation is an input for knowledge gaining. It helps create quality service delivery and excellent products to help in competitive benchmarking and creation of intellectual assets. Life-long leaning is a driving wheel for sustaining improvement to propel innovations and inventions. Further, in a changing academic environment learning organisations are creating and delivering timely solutions swiftly to end-users. Undeniably, what defines knowledge are simple competences that situate know-what into know-how by recognising know-who in a system for original contribution to knowledge.

Grover and Davenport (2001) [9] discuss knowledge creation is important for turbulent market improvement even though competition becomes intense needs some advantages. It suggests innovation is knowledge strengthening. This enables effective problem-solving in academic and competitive environment. Suggestions show knowledge is distinct, uniform and independent even when individuals and groups are working in networks at varying times. Different problem-solving helps organisational constituents in fostering knowledge creation, storages, transfers, applications and handling.

Rastogi (2000) [10] suggests how organisations are developing innovative products and services despite penetrating global competition and international threats in market place. Innovation fosters change and inventions even though knowledge management is fragile, leaky and sticky. These features of knowledge make it difficult and different in acquiring, creating, storing and utilizing knowledge. There are problems when knowledge has to deal with human cognitions and psychologies. It becomes important to understand knowledge can be challenging since human psychologies exist in decisions involving tuition, evaluations and awards.

Storing knowledge need finding out suitable ways of analysing and changing document and models to offer insights. This helps discern and understand knowledge retrieving and transfers. Knowledge from other artefacts is also important for helping resolve challenges that occur in transfer and storing of knowledge for its intending uses.

All processes of creating, converting, transferring, and storing of knowledge demand innovative ways of handing this fragile asset. This is essential for understanding and making sure dealing with knowledge is a volatile academic rigor. It must use creative ways to ensure that it does not lose its real meaning from conversion processes of facts, insights and concepts in documents and archives as in [8] Wadan (2005).

Understanding facts, insights, innovations and indigenous wisdoms play parts in data gathering for acquiring, creating, transferring and storing knowledge. Interviews involving respondents cater for thorough understanding of ideas and concepts in minds and those in hardcopy formats. The academic achievements involve human resource development. These need creative tangible and intangible assets. Creating, transferring and storing knowledge improves intellectual assets. These must contribute to body of knowledge for resolving problems about drinking water and academic achievements in schools.

V. MODEL AND HYPOTHESIS

This research model and hypotheses would use chi-square (x^2) to predict results. Also, study uses correlation coefficient (r) to show directions and strengths of relationship between safe drinking water and academic achievements. The model shows a simple conceptual framework as in Fig. 1.

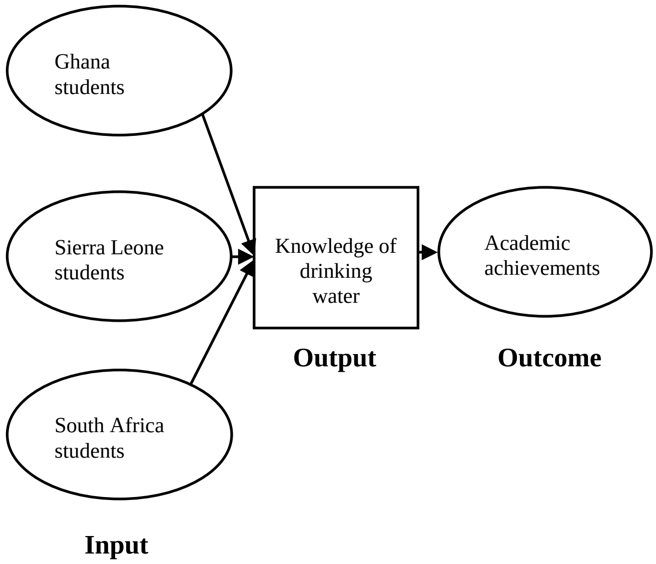

Fig. 1. Conceptual framework

Fig. 1. assumes test scores by students from Ghana, Sierra Leone and South Africa overtime will predict knowledge about drinking water and academic achievements. Number of students with mean scores at different times helps for finding out knowledge about safe drinking water and academic achievements. Key input represents independent variables, and output stands for predictable value. The outcome stands for dependent variable. Output yields of 432 numbers of mean scores from 195, 162 and 75 input in Ghana, Sierra

Leone and South Africa respectively. The hypothesis predicts results.

Hypothesis 1: *There is no relationship between safe drinking water and academic achievements in schools*

H_0**:** There is no relationship
H_1**:** There is a relationship

The calculating expected frequencies ($E_{r,c}$) use a formula

$$E_{r,c}=(r \ x \ c\ )/n. \quad (1)$$

where r is row count, c is column count and n is total number of observations. The chi-square (x^2) test calculation uses the formula

$$X^2 = \Sigma(O—E)^2/E. \quad (2)$$

where O and E are observed, and expected frequencies in k number of all classes. Chi-square test will find out critical value to reject null hypothesis.

Hypothesis 2: *There is negative relationship between safe drinking water and academic achievements in schools*

H_0**:** There is negative correlation
H_1**:** There is positive correlation

Computing the second hypothesis entails using the correlation coefficient (r) formula below.

$$r = \sum (x-\bar{x})(y-\bar{y})/(n-1)S_x S_y \quad (3)$$

where r is correlation coefficient, low and high represent values of x and y, $\bar{x}$ and $\bar{y}$ are means of these values, n is number of observations, and S_x, S_y are standard deviations. Formulae for standard deviations are as follows.

$$S_x = \sqrt{}\Sigma(x—\bar{x})^2/n—1, \text{ and } S_y = \sqrt{}\Sigma(y—\bar{y})^2/n—1 \quad (4)$$

First hypothesis helps to predict whether there is a relationship using chi square. To reject null hypothesis demands test statistic to be greater than critical value from chi-square table. S*econd hypothesis* will show a negative or positive correlation. It predicts directions and strengths of correlation between safe drinking water and academic achievements in schools.

Hypothesis 3: *Is there a relationship between safe drinking water and academic achievements in schools?*

Third hypothesis is a question that students answer by face-to-face interactions after scripts marking. A response is *in favour or against* notion that there is a relationship between safe drinking water and academic achievements in schools with brief explanation to these answers. Responses will undergo analysis using correlation for testing hypothesis.

VI. Assumptions and Methods

Main assumption is to prove no correlation exists between safe drinking water and academic achievements in schools. There is little or no knowledge about safe drinking water and academic achievements in schools. Respondents include pupils from kindergarten, primary and secondary schools, private remedial and training centres, colleges and universities. Parents and teachers are exempted from study, as focus was on examinees as they undergo training, studies, tests and examinations.

Study distances across three countries in two African socio-economic development sub-regions. These are Economic Community of West African States (Ghana and Sierra Leone), and Southern African Development Community (South Africa). Study focuses on students at different times and capture rural and urban schools. These include students from Bandajuma Kpolihun, Maloma, Segbwema, Kenema and Freetown in Sierra Leone. It captures learners from Winneba, Tamale and Accra in Ghana, as well as Mzinti, and Mbombela in South Africa. Study covers wide span of geographical space, because these countries have students from varying racial, tribal and religious denominations to influence thinking. In addition, these students are from various levels of academic knowledge and from different departments. This study triangulates by using mean scores, interviews and interactions in answering questions using *third hypothesis*.

The data gathering methods include five ways—first, testing students before sampling and initial instructions without drinking water to gather *dummy* data for control purposes. Second, testing after drinking water while participating in schooling exercises to help gather initial data from test scores.

Third method uses personal interactions and interviews to gather qualitative data to help investigator blend in with respondents during data gathering. Fourth, uses psychologies of drinking water during tests and examinations, for cognitive and environmental impact from data gathering. Fifth method involves interviewing psychologists, medical practitioners like doctors, surgeons, physicians and nurses for triangulating and having interdisciplinary data gathering.

The benchmarks hinge on number of students to score high grades after drinking water during studies, tests and examinations as against number of students scoring low grades because of ignoring drinking water. Students drink water and make high grades, and others are not drinking water score low grades in examinations. Labels for students are *high and low achievement indicators* to help calculate results.

TABLE I: Observed Academic Achievements

Input	Low scores (x)	High scores (y)	Examinees
Kindergarten and schools	89	90	179
Remedial and training centers	86	87	173
Colleges and universities	65	15	80
	240	192	432
Total	Coefficient(r) = 0.997		

VII. Results and Discussions

Random selections of examinations results and test scores for study are in following contingency tables. Table I has observed mean scores of examinations and tests of low and high indicators of students.

Contingency Table II tabulates expected results from study by computations. These frequency data are responses into chi-square formula for calculating test statistic.

TABLE II: Expected Academic Achievements

Input	Output	Exams mean scores Low	High	Total
Kindergarten and schools	Knowledge of drinking water	99.44	79.56	179.00
Remedial and training centers		96.11	76.89	173.00
Colleges and universities		44.44	35.56	80.00
Total		240.00	192.00	432.00

Computing test statistic in *first hypothesis* makes use of data in Table III and reading from standard chi-square Table IV for comparison.

TABLE III: Chi-Square for Academic Achievements

Input	Mean scores	Observed (O)	Expected (E)
Kindergarten and schools	Low	89	99.44
	High	90	79.56
Remedial and training centers	Low	86	96.11
	High	87	76.89
Colleges and universities	Low	65	44.44
	High	15	35.56
		Test statistic (x^2)= 7.973	

Value depends on degrees of freedom (*df*) as in formula:

$$df = (r—1) \times (c—1)$$

Number of degrees of freedom is (3-1) × (2-1) = 2. Looking up for df =2 and α =0.05, critical value is 5.991 as in Table IV. The test statistic is 7.973 as in Table III.

Chi-square test is to calculate test statistic and compare with critical value. As this results show test statistic of 7.973 is greater than 5.991 from standard chi-square distribution at 95 per cent confidence.

TABLE IV: CHI-SQUARE (X^2) DISTRIBUTION

df	Probability						
α	0.99	0.95	0.20	0.10	0.05	0.01	0.001
1	0.000157	0.003932	1.642	2.706	3.841	6.635	10.828
2	0.020	0.103	3.219	4.605	5.991	9.210	13.816
3	0.115	0.352	4.642	6.251	7.815	11.345	16.266
4	0.297	0.711	5.989	7.779	9.488	13.277	18.467
5	0.554	1.145	7.289	9.236	11.070	15.086	20.515

Source: Calculations using Microsoft Excel 2010. Reject the null hypothesis if the value of x^2 is less than calculated test value.

From this analysis, it is necessary to reject null hypothesis. Therefore, significant knowledge exists about *relationship between safe drinking water and academic achievements* in schools.

These results will undergo testing of *second hypothesis*. This will use correlation coefficient (r) to interpret whether correlation is negative or positive. Eventually, strength of knowledge will be part of interpretation.

TABLE V: CORRELATION COEFFICIENT FROM OBSERVE VALUES

Input	Low scores (x)	High scores (y)	Examinees
Kindergarten and schools	89	90	179
Remedial and training centers	86	87	173
Colleges and universities	65	15	80
	240	192	432
Total	Coefficient(r) = 0.997		

As model in Fig. 1 shows, examination results from schools, colleges and universities form part of data analysis. Input uses mean scores of past results from Ghana, Sierra Leone, and South Africa. Assessments entail finding out a correlation between safe drinking water and academic achievements. This encourages students to drink safe water during studies, tests and examinations in schools.

This test uses correlation coefficient as in Table V. The correlation coefficient lies between -1 and +1, and between -1 and 0 correlation is negative. Between 0 and +1 correlation is positive, while at 0 correlation has no mathematical notation. It has no correlation or direction.

In this study, correlation coefficient (r) is +0.997. It shows correlation is positive and since +0.997 lies over half on number line between 0 and +1, it is important *to state that strong positive correlation exists between safe drinking water and academic achievements* in schools.

Results show safe drinking water helps increase academic achievements of students. Thus, water is a *high-prize diet* for improving academic achievements in schools.

Information in Table VI offers data from interviews involving examinees to answering *third hypothesis* as model depicts. Table VI shows 188 responses from examinees:

TABLEVI: CORRELATION COEFFICIENT FROM INTERVIEW DATA

Examinees from:	Against (x)	In favour (y)	Responses
Kindergarten	11	13	24
Primary schools	12	10	22
Secondary schools	14	27	41
Remedial lessons	10	12	22
Training centres	13	14	27
Colleges	14	14	28
Universities	12	12	24
Total	86	102	188
	Coefficient (r) =0.588		

From Table VI, responses show about 45.74 per cent are against and 54.26 per cent in favor of notion that there is a relationship between safe drinking water and academic achievements in schools. Also, correlation coefficient of +0.588 shows a strong positive relationship exists between safe drinking water and academic achievements. Therefore, a *significant correlation exists between drinking water and academic achievements* in kindergarten, schools, remedial and training centers, colleges and universities!

VIII. Conclusion

Finally, despite many political and diplomatic sympathies about promoting drinking water, little attention in showing usefulness of drinking water for academic achievements is floating in the world. Study takes place overtime and in three countries in west and southern Africa. Research uses academic results using water during studies, tests and examinations to improve academic achievements. This study collects results to examine whether knowledge exist about safe drinking water and academic achievements from students at various levels of academic scalar chain.

Also, qualitative data gathering through personal communications with some students, psychologists and medical practitioners offer valuable data making it quintessential for knowledge and need for stronger study necessary. Nations, international institutions, schools, colleges and universities promotes knowledge about use of safe drinking water in schools. Thus, drinking water does not only help resolve problems of obesity, nutrition and health. It helps improve academic achievements in schools. Since human beings depend on water and knowledge for economic development, livelihood and survival, therefore;

"Water is the basis of life and the blue arteries of the earth! Everything in the non-marine environment depends on freshwater to survive"—Sandra Postel, Global Water Policy Project, 2004.

IX. RECOMMENDATIONS

Pupils, students and other leaners should drink safe water and less sugar drinks during studies, tests and examinations. These would help improve academic performance in schools. As this study shows there is strong and positive correlation between safe drinking water and academic achievements in schools, remedial centres and training schools, colleges and universities.

National and municipal policies should focus on improving safe drinking water in schools. Although many countries have policies about water uses in schools, it is not enough for improving academic achievements. Parents and guardians should encourage kids, wards and pupils as well as students to drink enough safe water during studies, at home, on campus and during tests and examinations. Therefore, policies should encourage drinking enough safe water in schools.

Use drinking water to presents nutritional programmes in schools and communities. There should be consistent advertising and other promotions about enough safe drinking water in schools, as these help improve health, sanitation and academic achievements. Further, there is strong and positive relationship between safe drinking water and academic achievements.

International institutions should have more interests in knowledge about drinking water and academic achievements in schools. A special appeal can be made to institutions like United Nations Educational, Scientific and Cultural Organization (UNESCO), and United Nations Children's Fund (UNICEF) to increase the need and funding for study into safe drinking water for learners in schools.

Universities and educational institutions must include safe drinking water and other water uses into the curriculum and policies on water conservation and water demand management to improve not only health, sanitation and nutrition, but academic achievements in schools.

Further research should capture policies for creating better academic achievements through safe drinking water in schools. These studies should look at the operational performances of students and the impact of drinking water on the overall academic achievements. This should capture students in primary and secondary schools, colleges and universities about drinking water and academic achievements.

More studies should also focus on the dietary ingredients of safe drinking water. The study should look at how this could help reveal potential, hidden results and new knowledge. Investigations should cover how and why safe drinking water has such impact on academic achievements among pupils, students, and other learners in west and southern Africa.

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