

NEW MEXICO TECH – EDUCATION AND PSYCHOLOGY DEPARTMENT

Using Improvised Instructional Materials to Teach Chemical Methods

Independent Study

Dorothy Mensah

7/30/2015

Abstract

Effective teaching of any subject will not only stimulate students' interest in the subject, but also enhance applicability of the concept in real life situations. To achieve effective teaching and learning process, there is the need for the use of instructional materials. Instructional materials are teaching aids which teachers employ to facilitate his or her teaching for the achievement of the stated objective.

The primary objective of this project was to make improvised instructional materials to teach students Acids and Bases concepts especially in rural areas and developing countries. When teaching in rural areas it is very difficult to get access to the standardized materials to teach Chemistry and other sciences that need hands-on activities. The main idea on which this work is based was the usefulness of improvised instructional materials to help areas which have limited resources in science teaching, particularly Chemistry.

A population of consisting of science teachers and middle school students were selected for this study. Mixed methods were used for the study. Data was gathered through the use of questionnaires, interviews, experiments, and observations.

The experimental aspect of this study involved two main stages: In the first stage, we used standardized materials for teaching acid and bases which includes litmus paper, burette, beaker and universal acid-base indicator to test prepared household materials which have basic and acidic properties like orange, lemon, soap, etc. Again, another experiment was performed to determine the concentration of potash in a wood ash solution using standard burette, beaker and universal indicator, and 1 Mole of HCL. In the second procedure improvised acid-base indicator and pH paper were produced and designed from red cabbage leaves juice, and these were used to test the same household materials again. Also the analyses of the wood ash solution were

determined again using cup in place of a beaker, and table spoon in place of a burette. The observed results in both experiments showed that improvised instructional materials gave the same learning effect as the standard instructional materials.

KEYWORDS: Improvised Instructional Materials, Standardized Instructional Materials, Science teaching, Rural Schools

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Chapter One

This chapter elaborated on the details of the study, which includes the purpose of the study, the statement of problem, significance of the study, and the research question for the study.

Introduction

Instructional materials used in teaching science helps to enrich learning; while the lack of these materials in the classroom makes teaching and learning less interactive and more difficult to understand. Most schools in the rural areas lack many of these instructional materials for teaching and learning of science. The inadequacy of these materials has been of serious concern to science teachers in rural areas (Aina, 2013). In developing countries, there is a high expectation from teachers even though there are scarce and limited resources to achieve these goals (Lingam and Lingam 2013). However, these instructional materials can be improvised in place of the standardized ones to bring about the same learning result as the standardized instructional materials.

Purpose of the Study

The main aim of this Project was to determine the effectiveness of improvised instructional materials to teach Acid and Bases concepts in schools, especially those in rural areas that lack the standard instructional materials in teaching Acid and Bases concepts. The study was also designed to investigate the knowledge and perceptions teachers and students have on the use of improvised instructional materials. In this study, improvised instructional materials were produced and designed to teach Acids-Bases concepts and these materials will serve as alternative instructional materials to teach science in schools, especially in rural areas where there are limited resources.

Significance of the Study

As a science teacher from a developing country, teaching science in these areas becomes very difficult, since it is taught from a more theoretical stand point and lacks the practicality of a concept. This is attributed to the lack of resources in these areas. This project was intended to make appropriate improvised materials in place of the standardized materials for teaching Acid and Bases concepts in science in order to enhance students' interest and performance in the study of the concepts, especially in schools that lack standardized instructional materials. Also the study will help to reveal the perceptions of teachers and students on the use of improvised instructional materials. Furthermore, it will help to know the effectiveness of improvised instructional materials in teaching Acid-Bases concept.

Research Questions

1. What are teacher's perceptions on the use of improvised instructional materials?
2. What are students' views on improvised instructional materials?
3. How often do teachers use improvised materials to teach?
4. Do improvised instructional materials give the same learning effect as the standardized instructional materials?

Chapter Two

Literature Review

This review of literature emphasizes the limitations of teaching science in rural schools, meaning of improvised instructional materials, improvisation used in other disciplines, as well as the importance and limitations of using improvised instructional materials.

Limitations of Teaching Science in Rural Areas

Science is a difficult subject to teach, especially in rural areas. Most teachers believe that lack of access to resources and equipment to teach science in these areas is a major obstacle to effective teaching (Laidlaw et al 2009). The unavailability of resources in rural schools restricts teachers' ability to be effective in facilitating teaching and learning process. The provision of an enriching educational experience relies on adequate resources in schools, such as science materials and equipment. Making teaching and learning materials accessible is recognized as vital in providing better learning opportunities to students. The scarcity of resources has a negative influence on the quality of education in remote schools. Inadequate resources for teaching and learning usually results in teachers having a less positive impact on students development (Lingam and Lingam 2013).

Teachers play a vital role in any education system, and students' learning in the classroom, but the quality of delivery has been adversely affected in rural schools due to challenges they faced such as lack of adequate resources (Shadreck 2012). There is a need for teachers to use indigenous materials in place of the standardized instructional materials to enhance teaching and learning especially in rural areas where resources are scarce.

Improvised Instructional Materials (IIMs)

Improvised instructional materials are teaching materials designed and produced from the available local materials in order to promote effective teaching and learning in schools. They are materials that are used in the absence of the original or the ideal objects to bring about the same learning effect that the standard materials would have brought (Ahmed 2008). Ndirangu et al (2003) investigated the effective use of improvised materials designed by science teachers during their teaching practice. This study presented evidence that improvised teaching aids designed by science teachers during practice had a great influence in the teaching of science in schools. These materials were found to be durable and could last for a longer time to enhance effective teaching and learning of science in school that are unable to afford expensive standardized instructional materials. Science teachers should be encouraged to make their own teaching resources from the locally available materials to teach science.

Improvised materials have been used across a number of scientific disciplines. For example, Ahmed (2008) presented in his study some biological instructional materials that biology teachers can improvise to replace the standardized ones. Biology teachers should find out materials from their local environment that they could improvise without losing the originality of the concept which is taught. Examples of these improvised materials include replacing D.N.A. models with stripped cardboard for illustration in teaching genetics, using clothes hangers (pegs) in place of test-tube holders, replacing measuring cylinders with graduated feeding bottles for measuring liquids and so on. Onasanya and Omosewo (2011) discovered in their study that the use of improvised instructional materials have the same importance in the teaching and learning of physics. This study's results showed that both improvised materials and standardized materials were successful in teaching the students. Science teachers should teach with

improvised materials if the standard ones are not readily available to enhance effective teaching and learning. Aina (2013) also investigated the necessity of using improvised materials to replace scarce standardized instructional materials in teaching physics in schools. This study showed the difficulty in teaching physics in schools where there is an unavailability of standardized instructional materials. Furthermore, the paper elaborated the use of improvised instructional materials in advancing teaching and learning of physics.

Similar studies have also been conducted in mathematics. For example, Clement et al. (2014) presented the effective use of improvised instructional material in teaching a concept in Geometry in higher levels. This study elaborated on the fact that teachers teach mathematical concepts abstractly. This is because some mathematics teachers believed that instructional materials used to teach this mathematics concept (Geometry) are not readily available or do not exist. Improvisation was applied in teaching geometry in this study, and from their results, the use of improvised instructional materials significantly improved students' performance more than teaching the concept without improvised materials. Ramel-galima et al. (2013) designed a color chart of Acid-Base indicators from indigenous plant extracts to assist in the teaching and learning of chemistry. The leaves and flower plants in the local environment were collected for the study. The paper discussed that plants are known to contain pigments like anthocyanin that provide color to their flowers, leaves, stem, root and fruits. The design of the color chart helped in teaching about acids and bases in the classroom.

Importance of using Improvised Instructional Materials (IIMs)

The use of locally produced instructional materials in teaching and learning has many advantages Ahmed (2008). The use of improvisation in teaching makes the concept more

practical and subsequently reduces abstractions. Again, they are cost effective, because they could be obtained from the local environment. They are generally very safe to use during demonstrations and experiments; it might not be capable of inflicting injuries, which means it could be hazard free. In addition, they serve as a motivation to learners inasmuch as they participate in the activities during the production of the materials and also arouse learners' interest. Moreover, the use of these materials minimizes concerns about breakage, repair and loss since they are readily available in the environment. It informs both students and teachers that alternatives for some of the conventional science teaching materials are possible. It also shows that people can do scientific experiments with the materials around them.

Furthermore, Ramel-galima et al. (2013) indicated that the use of indigenous local materials is definitely safer, cheaper and cultural-sensitive alternative to the use of commercial and factory-produced chemicals. When teachers and students use improvised instructional materials, it could lead to the discovery of new knowledge, and students' talents may be discovered. Using improvised instructional materials assist teachers economically and may make students more interactive. Beyond these, it makes students make use of their intellectual ability in the process of teaching and learning (Onasanya and Omesewo 2011). A very important opportunity of using improvised materials for experiments is that, it enables learners to participate fully in the actual construction of the apparatus and gives them more ideas about how such materials work. Again, improvised instructional materials bring home to the classroom, and clarify unfamiliar principles and concept of science to learners. More so, when teachers improvise instructional materials for teaching, teachers' develop their potentials.

Limitation of using Improvised Materials

Most improvised materials lack precision and accuracy in measurement which may eventually undermine the exact outcome of the experiment (Aina 2013). Sometimes the cost involved in designing these materials may be more expensive than buying the original ones. Again, the available material may not be suitable or appropriate for the lesson and can subsequently yield unexpected results. This can make learning more difficult and frustrating. Sometimes improvised materials may be expensive, and there may not be enough to teach a big class.

Furthermore, improvisation demands creativity, adventure, curiosity and perseverance on the part of the teacher, such skill can be realized through training programs with the instructional materials. The perception of some teachers towards improvisation could also affect other teachers positively or negatively in the production of instructional materials.

Chapter Three

Research Methodology

This chapter discusses the approach used for the study. This includes the population of the study, the study area, research instrument, research design, as well as the procedure for the research.

Research Population

A population consisting of teachers and students were selected from two schools: Cottonwood Valley Charter School in Socorro NM represented a school in the U.S.A. The participants were 7th and 8th grade. 8th grade consists of 16 students, and 7th grade consist of 19 students, constituting a total of thirty-five (35) students. Four teachers from this school participated as well. Seventh day-Day-Adventist Middle Schools in Ghana, West Africa represented a school from a developing country. Five science teachers in the middle school were interviewed and questionnaires were sent to them to answer on their views and knowledge on improvised instructional materials.

Research Instrument

Data collection was in three phases. Interviews, Questionnaires and experiments were employed for the study. The first phase was the interviews. Teachers within the population were interviewed to ascertain their views on the use of improvised instructional prior to the start of the experimental work of the study. The information gathered from the interviews was used to modify the quantitative research questions which were used for the study. In the second phase, questionnaires were used to gather data. Questionnaires consisting of four items were deduced from the research questions which were stated to gather the views of teachers on the study. Another set of questions were made for the teachers who participated in the experimental work for the study to answer after the experiment. Questionnaires which consisted of four items were

also used to gather data from students on their views and usefulness of improvised instructional materials, two of them were answered before the experiment and the other two were answered after the experiment.

The last phase of data collection was the experiment work for the study. Two major experiments were performed. The first experiment involved two main stages: In the first stage, standardized instructional materials were used to teach the concept (Acid and Bases). The materials used included standard litmus paper, and pH paper. These materials were used to test prepared solutions of household materials which are considered to have acidic and basic properties. The solutions prepared were, orange juice, lemon juice, tomato juice, soapy water, wood ash solution, milk, shampoo, vinegar, and baking soda solution. In the second stage, improvised acid-base indicator and pH paper were produced and designed using red cabbage juice and card stock to test the same solutions.

The second experiment was titration. Standard instructional materials were used to determine the concentration of potash in different volumes of wood ash solutions. The materials used were standard burette, a beaker, a universal indicator (phenolphthalein) and 1mole HCL. Then improvised materials were used to measure the concentration of the same volumes of wood ash solutions. The materials used included a cup in place of a standard beaker, and a teaspoon in place of standard burette.

Research Design

Both quantitative and qualitative questions were designed for teachers including science teachers to gather information. The experimental design for the study was in three stages: Pre-assessment – Experiment – Post-assessment. In the pre-assessment students were given questionnaires to

respond on the knowledge they had of the on improvised instructional materials. The students were placed into two different groups namely groups A and B for the experiment aspect. Group A were taught with standardized materials for teaching the concept (Acids and Bases) and Group B were taught with the designed improvised instructional materials. The groups were counterbalanced in the second experiment and Group A were then used the improvised materials in studying the concept and Group B used the standard materials in the study of the same concept. Both groups answered questions after the experiment to determine effectiveness of improvised instructional materials.

Procedure

Pre-assessment

Teachers within the population were first interviewed on their knowledge and perceptions on the use of improvised instructional materials. The responses gathered from the interviews were used to modify the quantitative research questions. The questionnaires were given to teachers and students who participated in the experimental work of the project to answer prior to the beginning of the experiments. Another set of questionnaires were sent to the school in Ghana that was chosen for the study. Five science teachers in the middle school responded to the questionnaires that were sent. Responses of the interview and the questionnaires were collected scored and analyzed.

Experimental Design

All Students within the population and four teachers in Cottonwood Valley Charter School participated in the experimental work. The procedures of the experiment were well explained to students before it started. Students were placed into two different groups, A and B. Group A

were taught with standard instructional materials and these materials were used to test solutions which were prepared from household materials which had acidic and basic properties. The group tested nine different solutions using litmus paper and pH paper strips and recorded their observation based on the color change of the litmus paper and the pH for each of the solutions were tested and recorded as well.

The second group (group B) designed and produced improvised pH paper, acid-base indicator from red cabbage. The red cabbage was cut into small slices. Enough water was used to cover the slices in a pot and it was boiled for half an hour. Blue-violet liquid was obtained after boiling and was allowed to cool down. Part of the liquid was used for acid-base indicator. Blue card stock was cut into rectangular shapes and was soaked in the remaining part of the blue-violet liquid. The card stock was removed from the liquid and allowed to dry. It was then cut into the strips about the size of the standard pH paper (detailed information is shown in the appendix). These materials (improvised pH paper and acid-base indicator) were used to test the same nine different solutions which Group A used the standard materials to test. They tested whether the solution was an acid or a base by adding few drops of the red cabbage juice to each solution and recorded their observation based on the color change. The pH of each of the solutions were tested and recorded as well using the improvised pH paper.

The groups were switched and Group A then produced and designed improvised acid-base indicator and pH paper using the red cabbage and followed the same procedure. They tested all the nine solutions and recorded their observations by indicating if the solution is a base or and acid and it's pH as well. Group B also used the standardized materials to text all the nine solutions and recorded their observations.

The second experiment which was performed was titration. A titration is a quantitative analytical technique where a solution of known concentration is used to determine the concentration of an unknown solution. Typically, the titrant (the know solution) is added from a burette to a known quantity of the analyte (the unknown solution) until the reaction is complete. The same groups of students A and B were used for this experiment. Group A used the standard burette, a beaker, Universal indicator (phenolphthalein) and 1M HCL to determine the concentration of potash in different amount of wood-ash solutions, the results were recorded and the number of moles for each volume of wood ash solution was calculated and recorded as well. Group B then used the improvised materials which are cup to replace a beaker, and tablespoon in place of the burette, acid-base indicator and 1M HCL to determine the concentration of potash (CO_3^{2-}). The chemical reaction of hydrochloric acid and potash is shown in the equation below:



The number of moles for each volume of the wood ash solution was calculated and recorded as well. The groups were switched and Group A used the improvised materials and Group B used the standard materials and the same procedure was followed to determine the concentration of the wood as solution and each group recorded their results.

Post-assessment

The post-assessment aimed at finding out the effectiveness of improvised instructional materials in teaching the concept of Acids-Bases. After the experiment students and teachers who participated in the experiment were given another set of questionnaires to answer on the usefulness of improvised instructional materials and if it gave the same learning effect as the standardized instructional materials.

Chapter Four

Results and Discussion

This chapter elaborates on the results and analysis of data collection. Several illustrative instruments are utilized to represent the results in this session. Statistical comparisons were used throughout the discussion to compare different outcomes in the analysis.

Responses to Research Questions

Research Question one: *What are teachers perceptions on the use of improvised instructional materials?*

This research question looks at the views of teachers on improvised instructional materials. In answering this question, teachers were interviewed. Five science teachers from Seven-Day-Adventist school in Ghana who were chosen for the study were interviewed on their views and knowledge on improvised instructional materials. Based on responses from the interviews, it reveals that three out of the five teachers had a fair knowledge on Improvised Instructional materials (IIMs); the teachers revealed that they aren't using have IIMs, yet they do not have the standard instructional materials for teaching these concepts. This is because they do not have in-depth knowledge on using these indigenous materials as substitutes for the standard ones. Also, they exhibited some misconceptions that improvised instructional materials could give the same learning effect as the standardized ones. From the teachers responses, they find teaching science very difficult because of unavailability of teaching resources. Again, the science teachers were asked how they teach Acid-Bases concepts and from their responses, the concept is taught abstractly instead of it being practical and that middle school students have not even seen litmus paper, pH paper and acid-base indicator.

Two out of the five science teachers had knowledge on improvised instructional materials, but from the responses they gave, it showed, they did not think substituting the indigenous materials in place of the standard ones will be effective.

The perception of the teachers from the chosen school in the America was very positive towards the use of improvised materials, even though these teachers have access to the standard instructional materials. Four teachers were interviewed. From the analysis of the teachers responses to the question above, two of them responded that, it is very economical and safe to use improvised instructional materials and students participate fully in the lesson if they use these materials in teaching a concept. The other two had a good perception about the use of improvised instructional materials, but they barely use them in teaching. This is mainly because of the availability of the standard instructional materials in their school. They think the improvised materials can bring about lowering of standards if they are used often, and that improvised instructional materials shouldn't take the place of standardized instructional materials. They believe improvised instructional materials should only be used for teaching if the standardized ones are unavailable.

Research Question Two: What are students' views on improvised instructional materials?

Students were given questionnaires to answer base on the above research question. Thirty-five students participated in answering the questions. Table 1 below shows the responses of students on the knowledge of improvised instructional materials.

Table 1: Responses from research question 2

Question	Responses (%)		
	No	Somewhat	Yes
Do you know the usefulness of these common household materials (red cabbage, orange, wood ash, lemon etc.) beyond their traditional use?	11 (31.43%)	20 (57.14%)	4 (11.43%)
Do you think these materials can be used to replace standard pH paper, acid-base indicator, and acid and a base?	19 (54.29%)	11 (28.57)	9 (17.14%)

Knowledge of students on the use of indigenous materials which was utilized for the study beyond their traditional use, 11 students responded they do not have knowledge on what those indigenous materials from our local environment can be used for beside their traditional use, 20 students responded they have a fair knowledge that those materials can be useful in the classroom beyond their traditional use. However, only four students responded that they know those materials can be very useful aside from their traditional use.

This information above is represented with a pie chart in the figure 1:

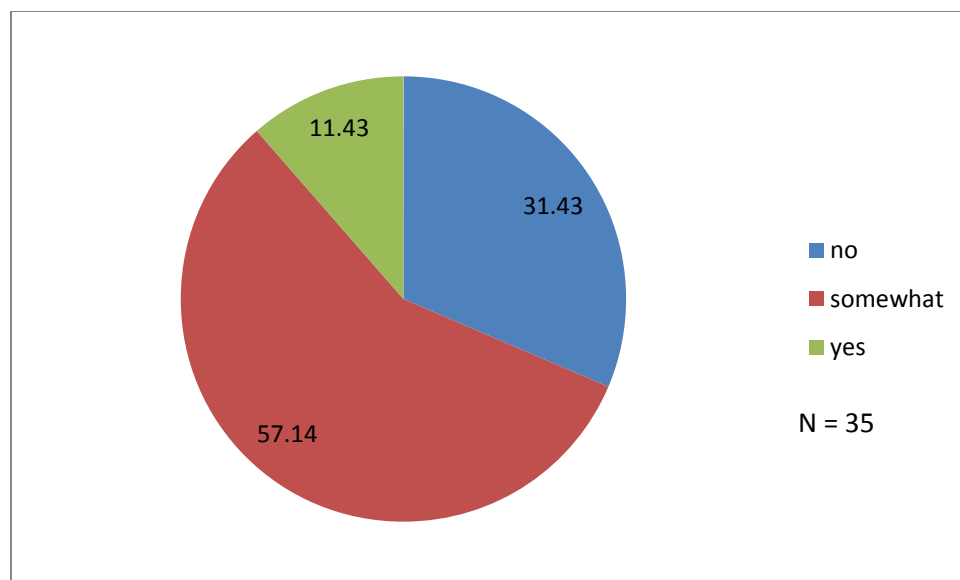


Figure 1: Students' knowledge on the indigenous materials

Moreover, students' views on those materials can be used to replace the standard instructional materials for teaching Acids-Bases concept, nineteen students responded they do not think those materials can be used to replace the original or standard materials for teaching the concept, eleven students responded that they think the household materials can somehow be used to replace the original instructional materials. But only nine students thought that the household materials can be used to replace the original or standard ones in teaching the concept.

The information above is represented in figure 2:

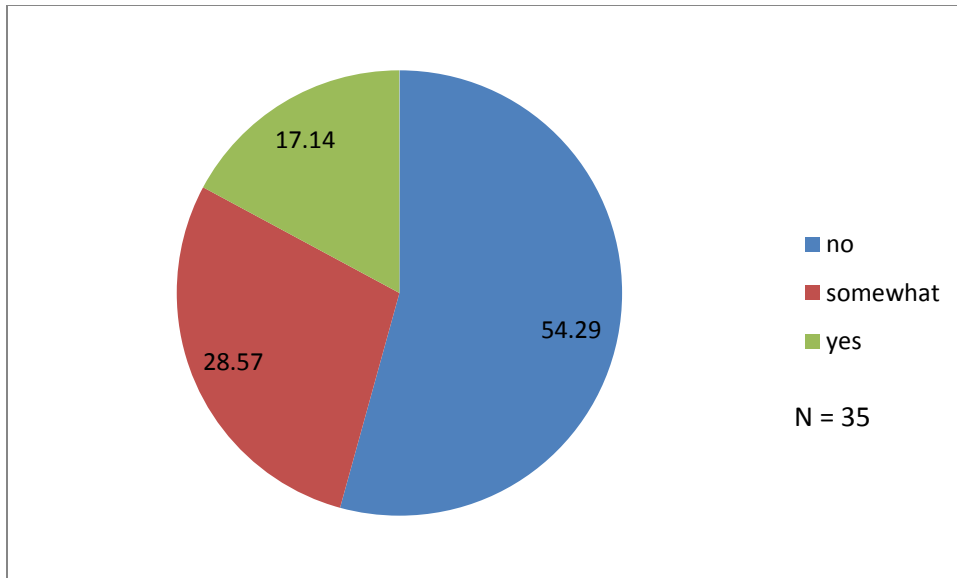


Figure 2: students' views on whether the indigenous materials can be used to replace the standard instructional materials

From analysis on research question two, it came to light that, most students in middle school do not have much knowledge on the usefulness of improvised instructional materials, which are materials that are found in our local environment to replace the standard instructional materials in the classroom. This is likely because they are often taught with the standard ones.

Research Question Three: How often do teachers use improvised materials to teach?

Questionnaires containing two options were given to teachers in answering the above question as shown in the table below:

Responses from teachers (America)

Table 2: Responses from research question three

Questions	Responses (%)			Total
	No	Yes		
Have you ever used improvised instructional materials in teaching a concept	1 (25%)	3 (75%)		4 (100)
	Rarely	Sometimes	Very often	
If yes, how often do you use IIM	1 (33.3%)	2(66.7)	0	3(100)

From the table above, only one teacher out of the four has never used improvised instructional materials in teaching a concept. On the question of how often these teachers use improvised materials, one teacher responded he rarely uses those materials and two teachers sometimes use these indigenous materials to teach. However, none of the teachers often use improvised instructional materials in teaching.

The information above is represented in the histogram below:

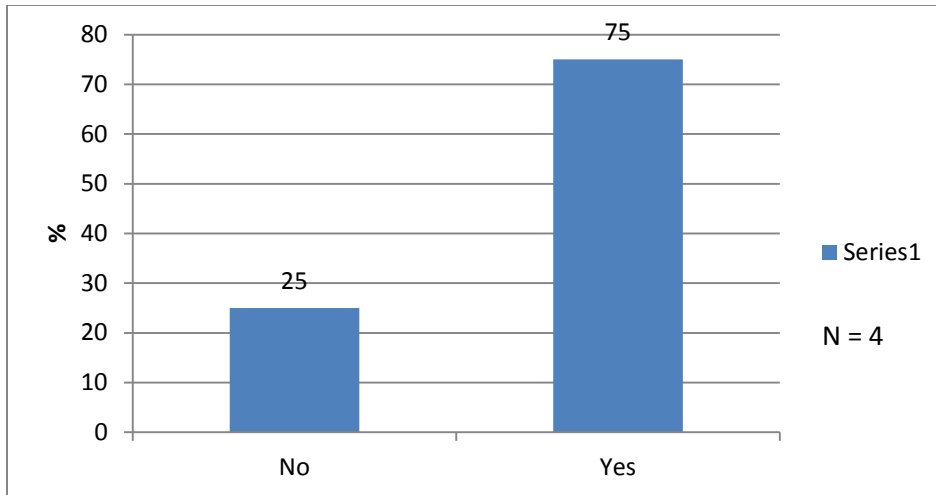


Figure 3: Teachers responses on if they have used IIMs before

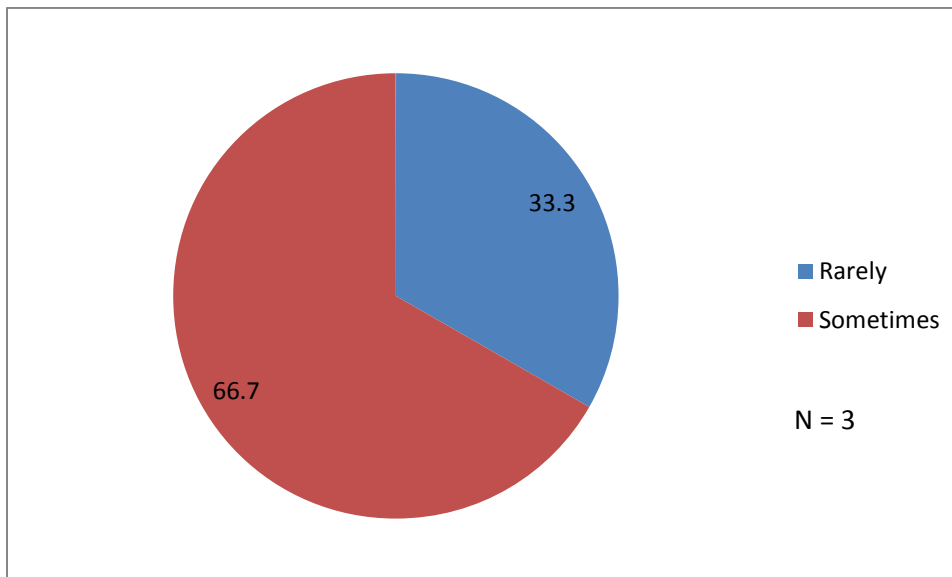


Figure 4: Teachers' responses on how often they use IIMs

Responses from teachers (Ghana)

These teachers were given a set of questions containing 3 items to answer. The table below shows the responses which were given by five science teachers from a rural school:

Table 3: Responses from teachers in Ghana

Questions	Responses (%)			Total
	Disagree	Agree	Strongly agree	
Do you think instructional materials could be obtained from indigenous materials in our environment	0	4 (80%)	1 (20%)	5 (100)
	No	Yes		
Have you ever used IIM in teaching a concept?	2 (40%)	3 (60%)		5 (100)
	Rarely	Sometimes	Very often	
If yes how often do you use IIM	2 (66.7%)	1 (33.3%)		3 (100)

From table 3, none of these teachers disagree with the fact that instructional materials can be obtained from common household materials. Four out of the five teachers agree that instructional material can be obtained from common household materials. This information is represented in the figure 5 below.

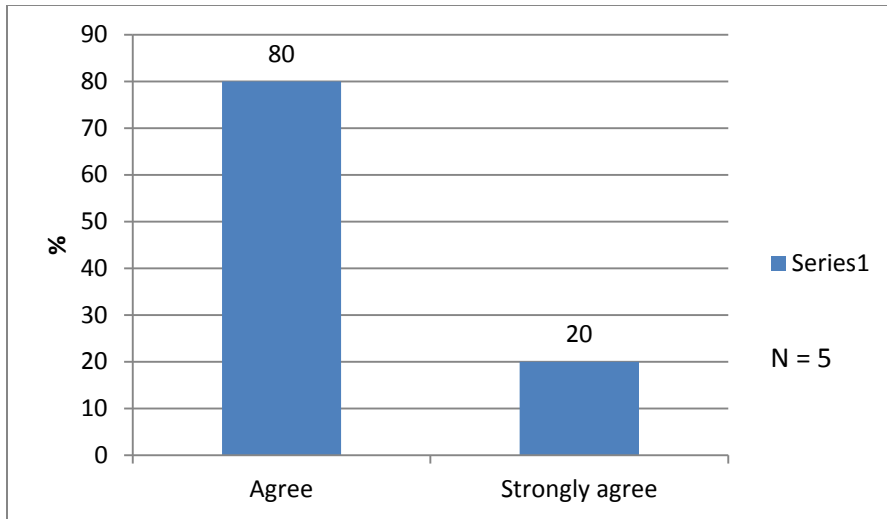


Figure 5: Teachers' ideas on whether instructional material could be obtained from the indigenous materials

From the responses of teachers on if they have ever used improvised instructional materials in teaching a concept as shown in table 3 above, only two of them have never used these materials and three have used these materials in teaching a concept. This is represented in figure 6 below.

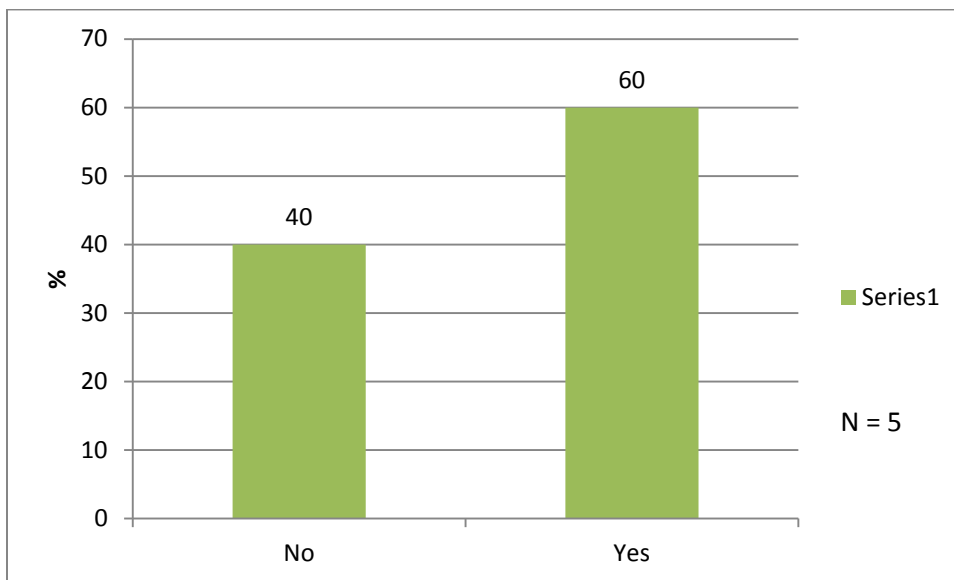


Figure 6: Teachers' who have used improvised materials in teaching

From the responses on how often these teachers use improvised materials, two teachers rarely use improvised instructional materials and one sometimes use these materials. But none of them responded to whether they use improvised materials often. This information is represented in figure 7 below.

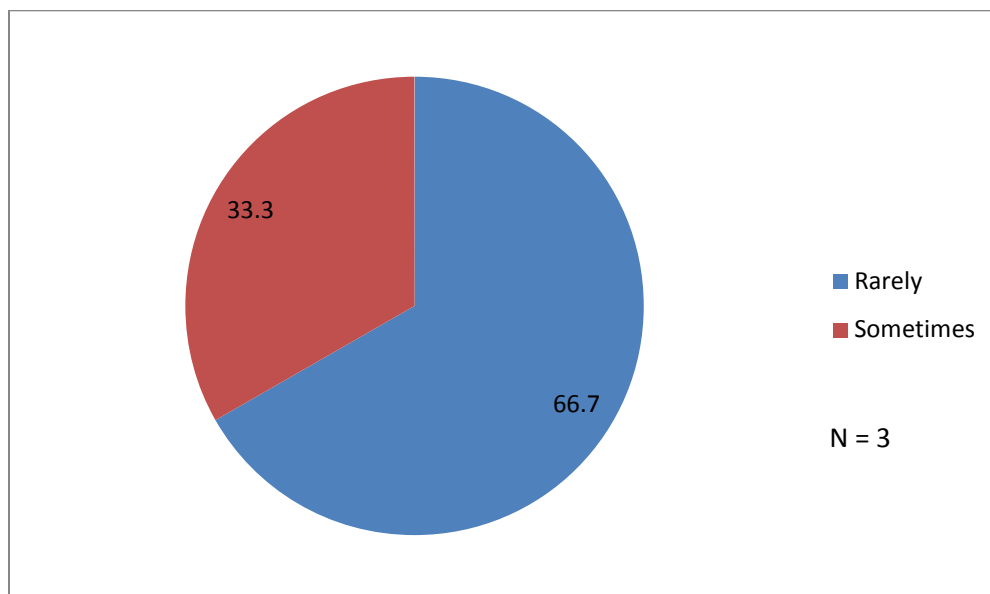


Figure 7: Teachers' responses on how often they use IIMs

From the analysis on research question three, it is evident that, the majority of the teachers surveyed for this study rarely use improvised instructional materials. It can be seen clearly from the findings that teachers from the chosen school in America sometimes use these materials as compared to the teachers from the chosen school in Ghana, even though teachers from the school in America have standardized instructional materials available in their school, but they still improvise when needed. However, the science teachers from the school in Ghana do not have

access to the original or standardized instructional materials, yet they rarely improvise to replace the standard ones in teaching a concept.

Research Question 4: *Do Improvised Instructional Materials give the same learning effect as the standardized instructional materials?*

Experimental design was used to answer this research question. Two experiments were performed using standardized and improvised instructional materials in teaching Acids and Bases concept. In the first experiment, standardized materials were used to teach the concept; students used the original materials to test if a solution was an acid or a base and subsequently tested the pH scale for each solution as well using the standard pH paper. Different groups of students were taught the same concept with improvised instructional materials. These students designed and produced improvised materials to replace the original ones to determine if the solution was a base or an acid and tested the pH of each solution as well using improvised pH paper designed. Table 4 below shows the results from the experiment.

Table 4: Results from both Experiments

SUBSTANCE S	LITMUS PAPER (COLOR)	ACID/BASE	RED CABBAGE JUICE (COLOR)	ACID/BASE	pH (pH paper)	pH (Improvise d pH paper) Color	Error Analyses (Accepted value – experimental value/accepted value*100%)
Baking Soda	Blue	Base	Green-blue	Base	9	8.5	5
Vinegar	Orange-red	Acid	red	Acid	2	1.5	5
Orange juice	Yellow-orange	Acid	Yellow	Acid	4	3.5	5
Lemon Juice	Red	Acid	Red	Acid	2	2.5	5
Tomato Juice	Greeny-yellow	Acid	Greeny-yellow	Acid	6	5.5	5
Milk	Green-	Acid	Green-	Acid	6	6	0

	yellow		yellow				
Shampoo	Dark-blue	Base	Purple-blue	Base	11	10.5	5
Wood ash solution	Dark-green	Base	Dark-green	Base	10	10	0
Soapy water	Purple-blue	Base	Dark-blue	Base	12	11.5	5

From the table above, nine different solutions were prepared and tested. All the nine solutions in the table above were first tested by a group of students with standard materials. Standard litmus paper was dipped into each of the solutions; the color change was recorded as shown in the second column on the table. The results from the test on whether the solution is an acid or a base was recorded based on the color change of the litmus paper as shown in the 3rd column of the table above. Drops of the improvised (red cabbage juice) acid-base indicator was added to each of the solutions and the color change was recorded in the 4th column of the above table. From the color change, students were able to determine if the solution was an acid or a base. This is recorded in the 5th column. The pH of each solution was determined using the standard pH paper and the results can be seen in column 6 of the above table. Again, the pH of the same solutions was tested with the improvised pH paper by different group of students and the results are indicated in column 7 in the table above. . From the analysis of the above results, it can be seen that improvised instructional materials gave similar results as standardized instructional materials. This can be inferred from the low error percentage shown in table 4.

The table below shows the results which were obtained from the second major experiment (titration).

Table 5: Results from the titration experiment

Standardized Materials			Improvised Materials			
Volume of Wood-ash (CO ₃ ²⁻) Solution in beaker	Volume of 1 mole HCL Solution used to titrate(burette)	Number of moles of CO ₃ ²⁻ = volume of HCl * Conc of HCl* (1 mol CO ₃ ²⁻ /2mol H ⁺)	Volume of Wood-ash Solution in a cup	Volume of 1 mole HCL Solution (teaspoon)(1tsp = 4.93 ml)	Convert Volume of HCl solution from milliliters to Liters	Number of moles of CO ₃ ²⁻ = volume of HCl * Conc of HCl* (1 mol CO ₃ ²⁻ /2mol H ⁺)
20ml	20ml = 0.02L	0.01	20ml	4.05 tsp=19.97ml	0.019L	0.01
30ml	30ml = 0.03L	0.015	30ml	6.08 tsp = 29.97ml	0.029L	0.015
40ml	40ml= 0.04L	0.02	40ml	8.11 tsp = 39.98ml	0.039L	0.019
55ml	55ml= 0.055L	0.028	55ml	11.16 tsp = 55.02ml	0.055L	0.028
65ml	65ml= 0.065L	0.033	65ml	13.19 tsp = 65.03ml	0.065L	0.033

Different volumes of 1 mole of HCL were used to determine the concentration of potash in wood-ash solutions, as shown in the table. A standard burette and beaker were first used by the control group (group A) to determine the concentration of the volumes of the wood-ash solutions. The number of moles for each of the wood-ash solution was calculated using the formula: # of moles = CV, where C= concentration and V = volume. An indicator was added to each of the wood ash solutions in the beaker and the color changed to red, then drops of the HCL were added to the wood-ash solution until the solution became clear, that is reached neutral pH. Since the concentration of the HCL solution was known, the concentration of the wood-ash solution was then calculated and this is recorded in the above table. A detailed calculation of this is found in the appendix (lesson plan). The experimental group (group B) used the improvised materials to determine the concentration of the same volume of wood ash solutions by using a tablespoon to add drops of 1mole HCl to the wood-ash solutions in a cup, the number of teaspoons used was counted until the solution reached neutral pH. The concentration of the wood

ash solutions were calculated again using the same formula, but we converted the volume of HCL solution which we used the teaspoon to measure into milliliters, that's 1 teaspoon = 4.93 ml and multiplied 4.93 to the number of teaspoon which was used to titrate to obtain the volume of HCl. The results from both experiments were analyzed and compared. From the above table, it can be seen that the concentration for the wood-ash solutions for both improvised and standard materials were the same.

Qualitatively, findings from the analyses of the experiments showed that the improvised instructional materials resulted in the same level of performance as the standardized instructional materials.

Results from Post Assessment

After the experiments, questionnaires were given to the students and teachers within the population to answer based on their observations and the results from the experiment.

Responses of students are shown in table 6 below:

Table 6: Students responses after the experiment

Question	Responses (%)			Total
	No	Somewhat	Yes	
Did students find the improvised materials useful in teaching the concept?	0	5 (14.29%)	30 (85.71%)	35(100)
	Disagree	Agree	Strongly Agree	
Do you think the improvised instructional materials performed well as with the standard ones?	0	13 (37.14%)	22 (62.86)	35(100)

From the responses of students as shown in the above table, it can be seen that, all the students found the improvised instructional materials useful, none of them checked no. Five students responded that the IIMs are somehow useful, but 30 students out of the 35 responded the IIMs were very useful in teaching the concept. This information is shown in the figure below:

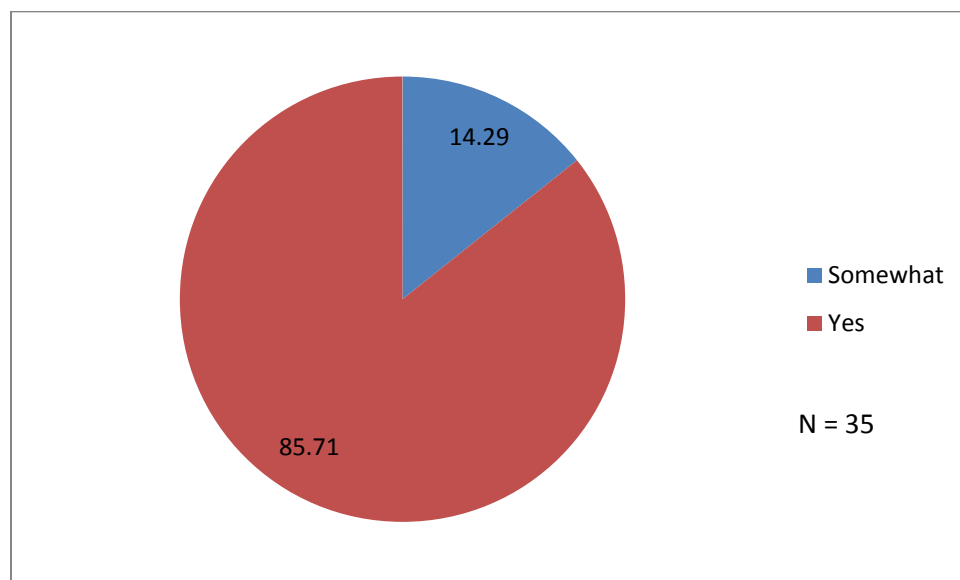


Figure 8: Students' responses on the usefulness of the improvised instructional materials

From the responses of students on if the improvised Instructional materials performed well as with the standard instruments, all the students were in favor that the IIMs gave the same learning effect as the standard ones. Thirteen students responded they agree that the IIMs performed well as the standard instruments. However, 22 students strongly agree with the fact that the IIMs performed well as with the standard instruments. This information is represented in the figure 9 below:

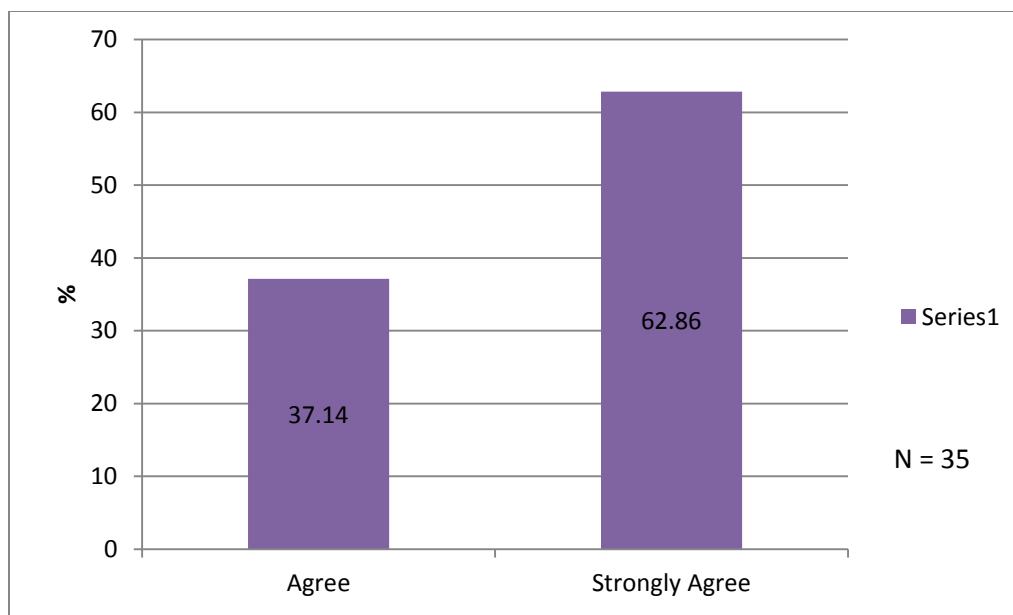


Figure 9: Students' responses on if the IIMs gave the same learning effect as the standard ones

Table 7 depicts the responses of post assessment of the four teachers who participated in the experimental work of the study.

Table 7: Responses from teachers after the experiment

Questions	Responses (%)			Total
	No	Somehow	Yes	
Did teachers find the IIM useful in teaching the concept?	0	1 (25%)	3 (75%)	4 (100)
	Disagree	Agree	Strongly agree	
Do you think the IIMs produced the same performance as the standard ones?	0	2 (50%)	2 (50%)	4(100)

From the table above, it shows that all the teachers were believed that improvised instructional materials were very useful in teaching the concept. From the results, one teacher responded that

IIMs was somehow useful, but three out of the 4 teachers responded that the IIMs were very useful. This information is represented in the figure 10 below.

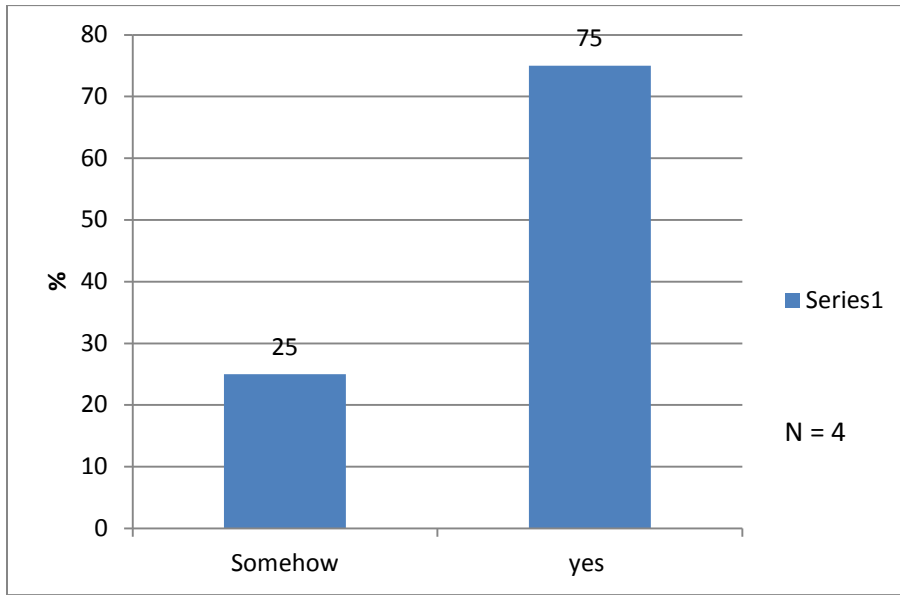


Figure 10: Teachers responses on the usefulness of IIMs

Two teachers responded they agree that the IIMs performed well as with the standard instruments and the other two strongly agreed as shown in table 7 above. This means that all the teachers who were present during the experiment agreed that the IIMs performed well as with the standard ones. This information is represented in the figure 11.

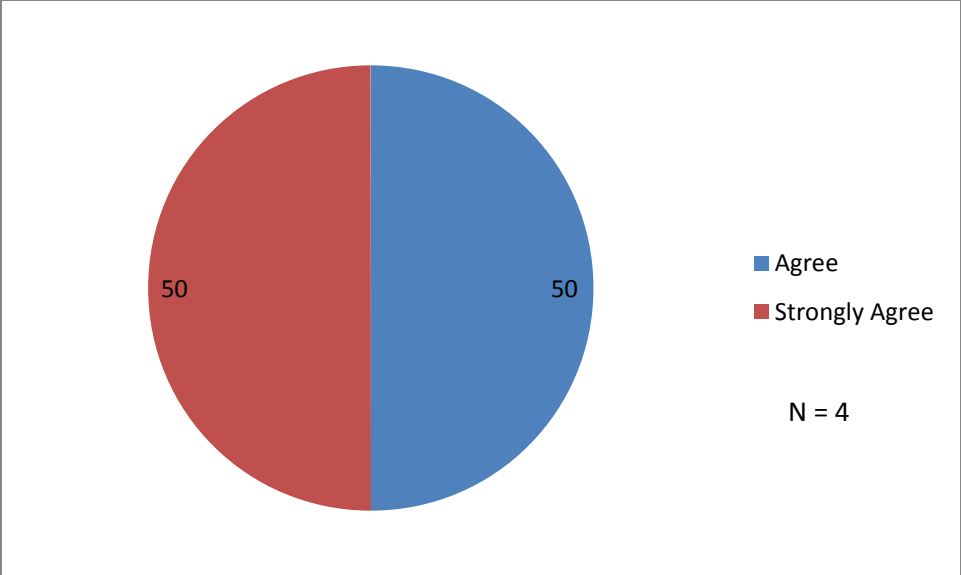


Figure 11: Teachers' responses on whether the IIMs performed well as with the standard ones.

Chapter Five

Conclusion and Recommendation

This final chapter presents limitations of the study, conclusions and recommendations for schools which have limited resources for teaching the concept.

Limitations of the Study

In conducting a research study, there are always problems which researchers can face. In the course of this study, one of the challenges which the researcher faced was the small sample size of science teachers who participated in the study. This problem hampered the results a little bit since it was difficult to make general conclusions on the findings of the study.

Conclusions

In the light of the above findings, it was discovered that the improvised instructional materials produced the same performance as standard instructional materials. From the results of the study, it can be deduced that improvised instructional materials were very useful in teaching the concept. From the analysis of teachers' perception towards improvised instructional materials; it reveals that teachers from the school in America who were selected for this study have positive views towards the use of IIMs as compared to the teachers from the Ghanaian school. Even though the teachers in the American school have standardized instructional materials available in their school, but they still improvise when needed.

Moreover, this study reveal that rural schools lack the standard materials for teaching the concept but the teachers do not have positive perception towards IIMs. Also the rural teachers do not have much knowledge to improvise in place of the original instructional materials to give the same learning effect as the standard ones. The improvised materials which were designed for the

study will be very useful to the rural schools that have limited or lack resources in teaching the concept.

Recommendations

The researcher recommends that improvised instructional materials should be used as a substitute to teach when the standard ones are not available, especially in rural areas where there are scarce resources in teaching Chemistry and other science subjects at all levels. Also science teachers who have access to the standard instructional materials in their schools are advised to use improvisation to assist students in discovery of the usefulness of indigenous materials in the environment. Moreover, these materials are cheaper, safer and students participate fully in the lesson if these materials are used.

Furthermore, education departments should set up workshops to train teachers in rural schools on the use of improvised instructional materials. Beyond these, the researcher recommends that teachers training institutions should incorporate the use of improvisation in their curriculum.

Additionally, further work is recommended using a large population to study the concept, in order to make general conclusions on the findings.

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Appendix A

Lesson Plan

General Information:

Teacher: _____ Date: _____

Subject: Physical Science Grade: 7-8

Lesson Theme: Using Improvised Instructional Materials to teach Acids and Bases

Length of Lesson: 3 class periods

Preparation before class:

Make I have read about the concept and have covered all aspects students need to know. Gather all teaching and learning materials which will be used for the lesson. Print out questionnaires and experimental procedures which will be used for the class. Prepare 5 minutes power point slides to introduce students to my research.

Lesson 1 (2 days): Comparing standard materials with improvised materials through experiments – 90 minutes each day

Objectives:

By the end of the lesson students will:

- Be able to use a litmus paper to establish a solution as a base or an acid based on the color change.
- Be able to use red cabbage juice to determine if a solution is an acid or a base.
- Determine the pH of known and unknown acids and bases using the pH paper
- Determine the pH of known and unknown acids and bases using improvised pH paper which they will design
- Gain insights about how household materials (improvised) gives the same learning effect as the known standard materials in teaching acids and bases

Understanding:

Students will understand the concept of improvisation.

Materials:

Standard Litmus Paper, Standard pH paper, tomatoes, lemon, orange, wood-ash, soap, red cabbage, shampoo, vinegar, baking soda, milk, safety goggles, Over-head Projector, cooking pot, filter paper, beaker, safety goggles, rubber gloves

Key Vocabulary:

Litmus paper, Acids, Bases, Solution, acid-base indicator, pH, pH scale, improvised instructional materials, standardized instructional materials

Pre-requisite:

Students have a basic idea about the properties of acids and bases and solutions

Activities:

1. Review students' previous knowledge on solutions and properties of acids and bases through questions and answers.
2. The teacher/researcher will give a brief presentation on the project she is working on and the benefits to students and explain the procedure students are going to follow for the lesson and explain the questionnaires they will answer
3. Give out questionnaires for the pre-assessment to students and other teachers who are present for them to answer. Collect all questionnaires after they are completed.
4. Give students printed copy of the keywords and discuss
5. Explain to students what they are going to do for the experiment. Give printed copies out to students on the materials and procedure for the experiment.
6. Group students into two, namely group A and B. Group A (control group) will use the standard litmus paper and pH paper to test solutions they will prepare from 9 household materials. Group B (experimental group) will produce acid-base indicator from red cabbage and design an improvised pH paper from red cabbage juice and card stock.

Guided Practice (Group A):

1. Students will follow the procedure given and prepare solutions with from the house household materials (lemon, tomatoes, soap, shampoo, wood-ash, vinegar, baking soda, orange, and milk)
2. They will put some amount of each of solutions prepared on a reaction plates and label each.
3. They will then place litmus paper in each of the solutions and record the color change, and indicate if the solution is a base or an acid based on the color change.
4. Students will now use the standard pH paper to determine the pH of each of the solutions.
5. They will put the pH paper strip in each solution and take it out and compare the strip with the pH chart and record the pH of the solution on their data table.
6. Discuss the results they had.

Guided Practice (Group B):

1. Students will prepare the improvised acid-base indicator and pH paper from red-cabbage juice
2. Cut the red cabbage into slices and put it in a pot, add water to cover it and boil for half an hour
3. Let it stand in the pot to cool down and pour the juice in a separate container.
4. Students will then cut the blue card stock into rectangular shape and soak it in the red cabbage juice so they will absorb it. After half an hour the cards will be removed from the juice and allowed to dry. For quicker drying we used a hair dryer.
5. Students will put the remaining juice of the red cabbage in a container and save it for acid-base indicator. They will now cut the dried card stock which was soaked into the red cabbage juice into the size of the standard pH paper.
6. Students will prepare solutions from the same household materials which group A used for their test.
7. Drops of the red-cabbage juice will be added to each of the solutions labeled
8. They will record the color change of each solution in their data table and indicate if the solution is a base or an acid based on the color change.
9. The group will use the improvised pH paper to test the pH of each of the solutions and record the pH of each in the data table.
10. Discuss the results

Guided Practice:

1. The groups will switch and Group A will produce and design improvised materials to test the same household materials following the same procedure Group B will use for their first experiment. Group B will also use the standard materials to test those materials again following the same procedure Group A will use for their first experiment.
2. Each group will record their observations and results

Closure:

Evaluate what students learned through questions and answers.

Assignment:

Each group will write a lab report on the results they had from the experiment

Lesson: Titration Experiment (Comparing standard instructional materials to improvised instructional materials) – 2 hours

Objectives:

By the end of the lesson students will:

1. Know and understand titration
2. Be able to determine the concentration of an unknown solution using standard materials
3. Be able to determine the concentration of unknown solution using improvised materials
4. Know the usefulness of improvised instructional materials

Understanding

Students will understand the basics of titration

Materials:

Standard burette, beaker, funnel, wood-ash, cup, teaspoon, 1 liter of 1 Mol HCL, safety goggles, rubber gloves, overhead projector, phenolphthalein

Key Vocabulary:

Titration, concentration, number of moles, solution, improvised materials

Pre-requisite:

Students have learnt about solvents and solutes and then how to determine the exact amount of solute dissolved in a given amount of solvent (Concentration)

Activities:

1. Review students previous knowledge on concentration through questions and answers
2. Give a brief presentation on the experiments which students are going to do and the significance of the whole work.
3. Introduce students to what is meant by titration and discuss. Let students know that, Acids and bases react in a 1:1 ratio. When you add base to acid (or vice versa), once the pH is neutral (7), you know that you have equal parts acid and base present. If you keep track of how much solution you've added to reach neutral pH you can determine the concentration of the unknown! This process is called titration. Titration is when a solution of known properties (called

the titrant) is used to analyze properties of an unknown solution. Titrations are often used in acid-base chemistry to determine the concentration of an unknown solution.

4. Have students go through the printed notes on titration and ask questions and then discuss the general idea of titration
5. Teach students how to calculate the number of moles of an unknown solution using the formula: Number of Moles = CV, where C = concentration, V = Volume. Do some examples with students using this formula.
6. Group students into 2, group A and B. Group A will use the standard materials to perform the titration experiment and group B will use the improvised materials to perform the same titration experiment

Guided Practice (Group A):

1. Give out the materials needed to perform the experiment to the group, that is standard burette, beaker, wood-ash, de-ionized water, filter paper and funnel.
2. Students will prepare wood-ash solution, by adding some amount of the de-ionized water with the wood ash solution and stir well, then filter.
3. Students will make different volumes of the wood ash solution in different beakers.
4. They will add drop of phenolphthalein to the solution
5. Fill burette with the same HCL solution. Note: The volume of HCL solution should be the same as the volume of wood-ash solution.
6. Add drops of the HCL to the wood ash
7. Repeat this experiment using different volumes of the solutions
8. Calculate the number of moles of CO_3^{2-} using this approach:

$$\text{Number of moles } \text{CO}_3^{2-} = \text{Volume HCL} * \text{Concentration HCL} * 1 \text{ mol } \text{CO}_3^{2-} / 2 \text{ mol } \text{H}^+$$

Note: 1000 ml = 1 L, so the volume of the HCL in milliliters should be converted to Liters before calculating the number of moles of CO_3^{2-}

For examples if the amount of HCL which was used to titrate 10 ml of CO_3^{2-} was 10 ml

It can be calculated as this:

Volume of HCL = 10 ml, there 10 ml = 10/100 = 0.01 L

Therefore:

$$\begin{aligned} \text{Number of moles } \text{CO}_3^{2-} &= 0.01 \text{ L} * 1/1 \text{ L} * 1 \text{ MOL } \text{CO}_3^{2-} / 2 \text{ mol HCL} \\ &= 0.005 \text{ mol } \text{CO}_3^{2-} \end{aligned}$$

9. Students will calculate for the number of moles of each of the experiment they perform.

Guided Practice Group B

1. The group will use the improvised materials to perform the same titration experiment

2. They will use a measuring cup in place of the beaker and teaspoon in place of the burette
3. Students will prepare wood-ash solution, by adding some amount of the de-ionized water with the wood ash solution and stir well, then filter.
4. They will add drop of phenolphthalein to the solution
5. Use the teaspoon to add drops of HCl to the wood ash solution in the cup. Note: The volume of HCl solution should be the same as the volume of wood-ash solution.
6. Repeat this experiment using different volumes of the solutions
7. Calculate the number of moles of CO_3^{2-} using this approach:

$$\text{Number of moles } \text{CO}_3^{2-} = \text{Volume HCl} * \text{Concentration HCl} * 1 \text{ mol } \text{CO}_3^{2-} / 2 \text{ mol } \text{H}^+$$

Note: 1000 ml = 1 L, so the volume of the HCl in milliliters should be converted to Liters before calculating the number of moles of CO_3^{2-}

Since we used a teaspoon, we have to convert the number of teaspoon into milliliters.

Since 1 tsp = 4.93 ml, we can convert the volume of HCl to milliliters.

Example if we used 2 tsp of HCl to titrate 10 ml of so CO_3^{2-} solution,

We first do the conversions. Since 1 tsp = 4.93 ml, 2 tsp = 9.86 ml which approximately 10 ml

To calculate for the number of moles we use:

Convert 9.86 ml to Liters = $9.86/100 = 0.00986$

Therefore # of moles $\text{CO}_3^{2-} = 0.00986\text{L} * 1\text{molHCl/L} * 1 \text{ mol } \text{CO}_3^{2-} / 2\text{molH}^+$

Number of moles $\text{CO}_3^{2-} = 0.00493$

8. The group will calculate the number of moles from the results of their experiment using the approach above while teacher go round to see if students are on task and are getting it.

Guided Practice:

9. The groups will switch and Group A will use the improvised materials for the same titration experiment and group B will use the standard materials to perform the titration experiment following the same procedures above.
10. Each group will record their observations and results

Closure:

Evaluate what students learned through questions and answers.

Assignment:

Each group will write a detailed lab report on the results they had from the experiments

Results from the Titration Experiment

Group A (Standard Materials)

Volume of CO ₃ ²⁻	Volume of 1 mol HCl	Number of moles of CO ₃ ²⁻ = volume of HCl * Conc of HCl* (1 mol CO ₃ ²⁻ /2mol H ⁺)
20 ml	20ml = 0.02 L	0.01
30 ml	30ml = 0.03 L	0.015
40 ml	40ml = 0.04 L	0.02
55 ml	55ml = 0.055 L	0.0275
65 ml	65ml = 0.065 L	0.0325

Group B (Improvised Materials)

Volume CO ₃ ²⁻	Volume of 1 mol HCL 1tsp = 4.93 ml (4.93*number of tsp = volume)	Volume of 1 mol HCl Convert from ml to L	Number of moles of CO ₃ ²⁻ = volume of HCl * Conc of HCl* (1 mol CO ₃ ²⁻ /2mol H ⁺)
20 ml	4.05 tsp = 19.966ml	0.0199L	0.01
30 ml	6.08 tsp = 29.9744ml	0.0299L	0.0149
40 ml	8.11 tsp = 39.9823ml	0.039982L	0.019
55 ml	11.16 tsp = 55.02ml	0.055L	0.0275
65 ml	13.19 tsp = 65.03ml	0.065L	0.0325

Appendix B

Procedure used to producing and designing the Improved pH paper and acid-base indicator



Figure 12: Red Cabbage



Figure 13: Cut Slices of Red Cabbage



Figure 14: Put the Slices in a Pot and Boil for half an hour



Figure 15: Pour the red cabbage juice in a container after it cools down

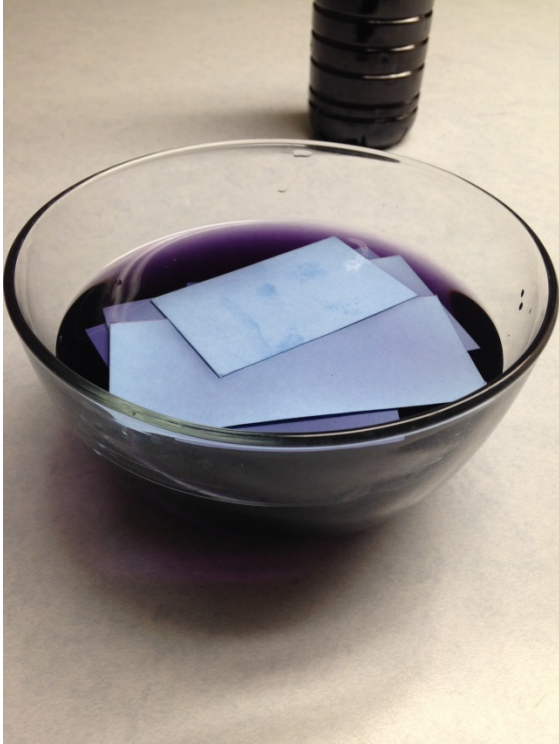


Figure 16: Cut card stock into rectangular shape and soak it in the red cabbage juice for half an hour

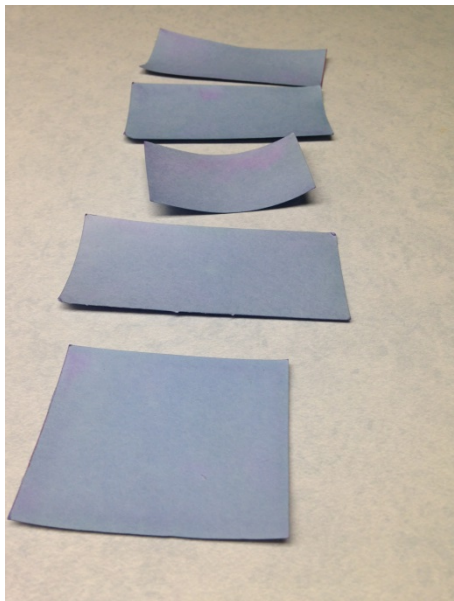


Figure 17: Dry the cards on a flat surface, for faster drying a hair dryer is used

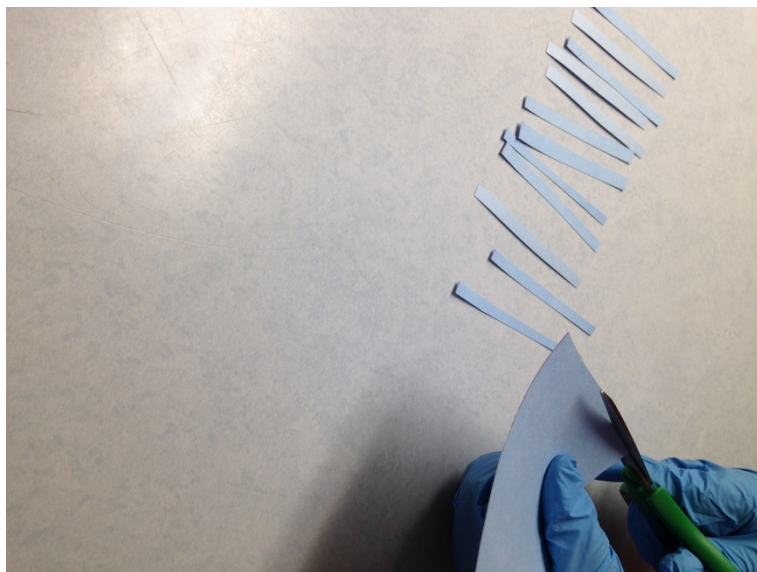


Figure 18: Cut the dried cards into strips and use it to test the pH of solutions



Figure 19: Red cabbage juice in vinegar

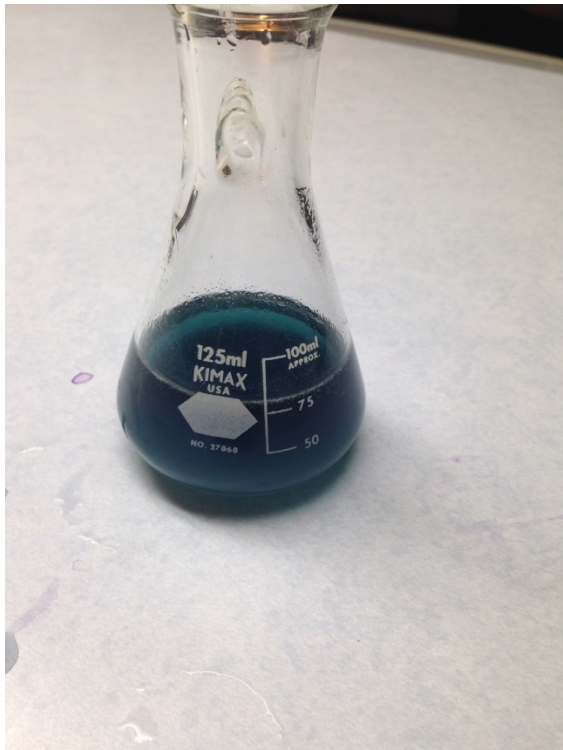


Figure 20: Red cabbage juice in baking soda

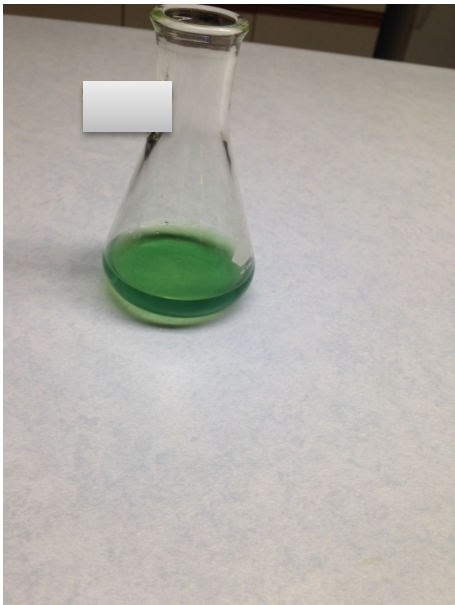


Figure 21: Red cabbage juice in wood-ash solution



Figure 22: Red cabbage juice in lemon juice

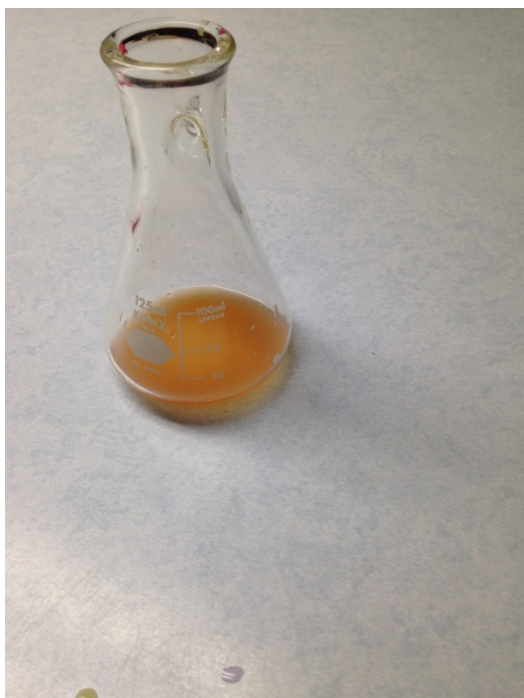


Figure 23: Red cabbage juice in orange juice

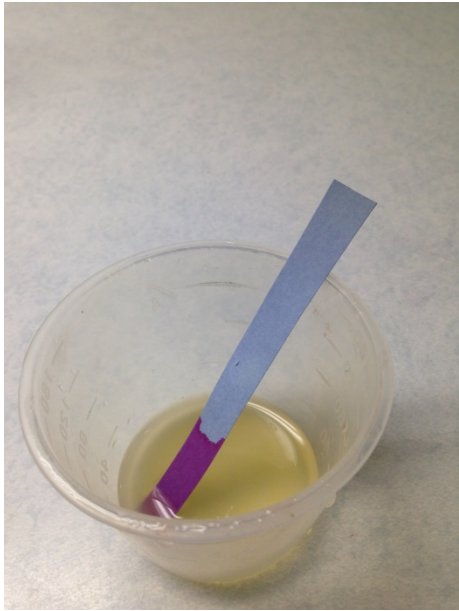


Figure 24: Improved pH paper in lemon juice



Figure 25: Improved pH paper in vinegar

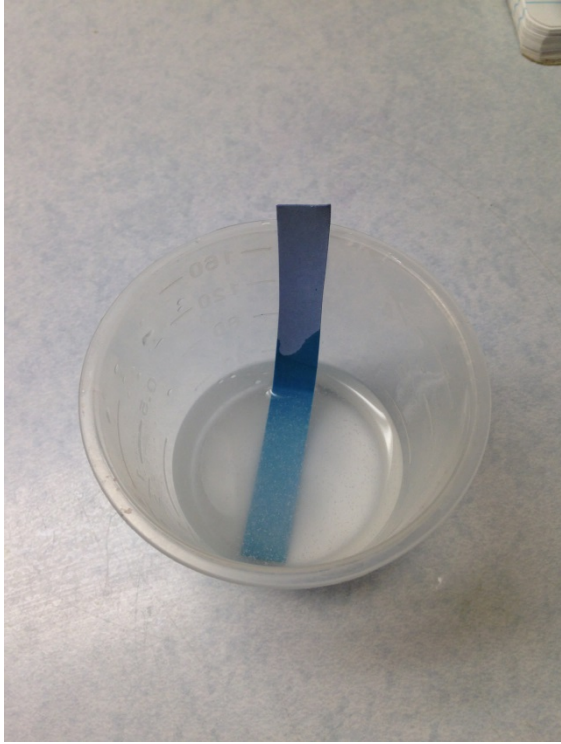


Figure 26: Red cabbage juice in baking soda