Localized Apparatuses in Teaching Electrical Conductivity of Aqueous Solutions

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Abstract

The study sought to determine as to which among the three proposed apparatuses namely: localized aqueous solution lamp, localized aqueous solution mini fan and localized aqueous solution Ferris wheel best demonstrated electrical conductivity of aqueous solutions and its effectiveness. It also sought to find out the perception of students when these localized apparatuses have been utilized in the activity. The respondents of this study were the 123 Grade 7 students of Pantao National High School, school year 2018-2019. The researcher utilized the descriptive method. The researcher also used validated questionnaires that measured the performance and perception of the students. The statistical tool used in the study includes, mean, t-test for independent data, weighted mean, Spearman rank correlation coefficient and ANOVA. The result of the study indicated that the posttest performance of the students did not meet expectationswhereas, their pretest performance was generally in satisfactory level. The marked improvement of their performance was attributed from the utilization of locally made apparatuses. Moreover, the study revealed that the three apparatuses had different effects among the students where, localized aqueous solution lamp had better effect on students, while localized aqueous solution mini fan was as good as miniature Ferris wheel. Further, the extent of perception among students on the utilization of localized apparatuses in terms of motivation, cognition and interaction was high.

Keywords: *Localized apparatus, perception of students, and electrical conductivity of aqueous solutions*

Introduction

Experiential learning is at the center of DepEd's new curriculum. It shifts from a teacher centered into a student-centered classroom. It also focuses on student's manipulative skills rather than merely academic skills (Montebon, 2014). Surely, the new curriculum is of great help among learners especially those who are poor in academics, for it does not only showcase one's intelligence but one's ability as well.

One of the best applications of this curriculum is on Science class. Since then, experiential learning has been used during Science class through experimentation. It cannot be denied that it has a great impact towards students' learning and retention. However, the implementation of the said curriculum, also results to challenges which hinder learning and retention. According to Aina (2013), the lack of laboratory apparatuses is the root cause of such challenges. Out of 5, 359 public high schools in the Philippines, only 4,060 have Science laboratories. The ratio is 1,325 students to 1 laboratory and not all of these laboratories contain enough apparatuses and equipment. The lack of laboratories and laboratory apparatuses are evident in public schools especially in far flung areas as it is one of the grievances of teachers and students. The Department of Science and Technology also unveils that scarcity of laboratory apparatuses and equipment affects the Filipino students' academic performance especially in Science.

Aligned with DepEd Order 45 Series of 2013, this problem has been addressed, wherein 2,966 recipient secondary public schools are given basic Science and Mathematics equipment. The Department of education aimed to ensure quality learning among students under the K to 12 curriculums.

However, until the present, there are a number of secondary public high schools which are still in need of laboratory classrooms and laboratory apparatuses. Hence, while the Department of Education is still coping to provide materials to all schools, localized apparatuses are the best answer to provide students quality learning with less expenditure. While there have been a number of valuable studies on the use of locallized laboratory apparatuses, there is a dearth of local implementation because of the lack of improvisation know-how among teachers (UNESCO Education Sector).

In addtion, the localized apparatus are also of great help especially to students enrolled in far-flung and sitio schools and to teachers assigned in the hinterlands who have no access to internet and Science materials (Paunan, 2013). Hence, the researcher wishes to study the effectiveness of the utilization of localized apparatuses in teaching Science concepts specifically the electrical conductivity of aqueous solutions, which is one of the least learned skills in science 7, identified by the Depeartment of Education. The researcher also sought to find out which among the three localized apparatuses namely, localized aqueous solution lamp, mini-fan, and miniature Ferris wheel would best demonstrate the said lesson.

Moreover, the study is different from other studies for the said topic has not been utilized as a subject for the utilization of localized apparatuses. In addition, the use of localized apparatuses in discussing the electrical conductivity of aqueous solutions not only focuses on its effectiveness, but also geared towards students' ingenuity to construct laboratory apparatuses based on the given guide. It also showcases students' initiative to visualize Science concept through the locally available materials.

Research Design

The researcher utilized a descriptive method of the study. It is descriptive because (a) it determined as to which among the three localized apparatuses best demonstrate electrical conductivity of aqueous solutions, (b) described the students' performance and retention when the lesson was aided with locally made apparatuses, (c) it also described the students' perception when localized apparatuses was applied in the lesson. Moreover, the apparatuses used in teaching electrical conductivity of aqueous solution were designed by the researcher.

Research Environment

The study was conducted at Pantao National High School, Mabinay District 1of the 2nd Congressional District of Negros Oriental and is located in Barangay Pantao 1, Mabinay, Negros Oriental. Pantao 1 is a barangay school located 89.5 km from Dumaguete City.

Pantao National High School is a medium school located along the National Highway. For the present school year, there are a total of 524 students enrolled in the school, 447 Junior High School students and 77 Senior High School, with an average class size of 50 students per section. It is one of the high schools in Negros Oriental which adopted the K to 12 curriculum. The number of teachers and classrooms in the said school is already enough to cater all the students enrolled. Classrooms and other facilities are also conducive to learning, with enough water supply and electrical connection. In addition, although internet connection is limited, the school makes sure that no students will be left behind in terms of computer literacy. However, with the advancement of the new curriculum, the school is still coping with the facilities and equipment needed for instructions. Evidently, the school is in scarce of laboratory apparatuses, the available resources are only limited on measuring apparatuses, glass wares and a few microscopes.

Research Respondents

The research specifically concentrated on the 3 grade 7 heterogeneous sections with a total of 123 students. These are the students who performed the experiment. In addition, Electrical conductivity is one of the lessons in Science 7 which was already taken by these students.

Research Instruments

To determine the effectiveness of the said apparatuses the researcher prepared a set of pre-test and post-test based on a Table of specification made by the researcher and a survey questionnaire intended for the respondents. The items of the pre-test and post-test were based on the lesson “electrical conductivity of aqueous solutions”. Moreover, the questionnaire discussed about the student’s perception in terms of motivation, cognition and interaction. The researcher consulted the experts for the areas covered in the study to ensure content validity of the research instrument. A dry-run was conducted for the test-questionnaire, pre-test and post-test among thirty respondents of each apparatus who were not included in the list of final respondents. Tallied result was computed for item reliability and validity, through item analysis and test-retest method.

The researcher devised a construction guide and experimental guide which served as the basis in constructing the localized apparatus and in conducting the experiment respectively. The data gathered in the experiment were computed and compared to the standard values to determine the effectiveness and accuracy of the apparatus.Furthermore, through analysis of variance, results indicated a p- value which is greater that the level of significance. Thus one can conclude that the three groups of students had more or less the same capabilities in Science subject.

Research Procedure

A letter of request was made by the researcher for the distribution of the final questionnaires. It was signed by the dean of the Graduate School and was transmitted to the Division Office for approval from the Division Superintendent. The endorsement and the approved letter from the Schools Division Superintendent together with a letter of request were presented to the District Supervisor for formal permission. The approved letter wasgiven to the principal of the respondents for formal permission.

After it was approved by the principal, the researcher visited each classroom to meet and inform the advisers. The same group of students as their sectioning was utilized during the experiment. The said sections were already grouped heterogeneously from the start of the school year. Each section was randomly assigned a localized apparatus to be utilized during the experiment. This was done through drawing of lots. During the conduct of the experiment, the researcher personally gave the instruction and purpose of the research. A pre-test was then handed out for the students to answer. After answering the pre-test, a short discussion was done by the teacher. Then a laboratory manual was given to each group for them to perform the experiment. The same group with their laboratory group was utilized in the study. The teacher facilitated the class while the activity was going on. One hourwas the allotted time for this experiment, within the allotted time students were able to perform the experiment, observe, record the data that were gathered and answered the guide questions on the laboratory manual. A post-test was given to each student after the experiment. Then, a survey questionnaire was handed to each student so as to identify his or her perception when localized apparatus was used in in terms of motivation, cognition, and interaction. Then the questionnaires were retrieved after the respondents answered the question. The data were collected and computed for accuracy and consistency then results were interpreted.

Findings

Table 1. Pre-test Performance of the Students

Group of Students Under Localized Aqueous…	n	$\bar{x}$ (%)	sd	Verbal Description
Solution Lamp	43	67.26	22.51	Did not meet expectations
Mini Fan	33	68.39	22.83	Did not meet expectations
Miniature Ferris Wheel	47	67.91	34.43	Did not meet expectations

Legend: Rating	Verbal Description
90% - 100%	Outstanding
85% - 89%	Very Satisfactory
80% - 84%	Satisfactory
75% - 79%	Fairly Satisfactory
Below 75%	Did Not Meet Expectation

The data in Table 1 reflect the pretest performance of the 3 sections with their respective localized apparatus in electrical conductivity of aqueous solution. The table shows that the performances of the 3 sections do not meet expectations based on the Revised Bloom's Taxonomy (DepEd Order No. 8, s 2015). This means that the student struggles with his/her understanding; prerequisite and fundamental knowledge and/or skills have not been acquired or developed adequately to aid understanding. This implies that the students, struggle in remembering, understanding, applying and analyzing the concept of electrical conductivity and their skills have not been improved to lessen this challenge, hence, this lesson is not properly grasped by the students.

The data presented is in line with the results of the study conducted by the Science Education Institute, the Department of Science and Technology, and the University of the Philippines National Institute for Science and Mathematics Education Development (2011) which aims in assessing Science framework for Philippine education. The study reveals that most of the students have limited analytical skills, have low retention in science concepts and neither can apply real life problem-solving situations nor design an investigation to solve a problem.

Table 2. Post-test Performance of the Students

Group of Students Under Localized Aqueous…	n	$\bar{x}$ (%)	sd	Verbal Description
Solution Lamp	43	84.19	10.34	Satisfactory
Mini Fan	33	78.06	10.19	Fairly Satisfactory
Miniature Ferris Wheel	47	79.50	11.81	Satisfactory

Legend: Rating	Verbal Description
90% - 100%	Outstanding
85% - 89%	Very Satisfactory
80% - 84%	Satisfactory
75% - 79%	Fairly Satisfactory
Below 75%	Did Not Meet Expectation

The data in Table 2 reveal the post-test performance of the students in Electrical conductivity of aqueous after the utilization of the different localized apparatuses. The data reflect that Localized Aqueous Solution lamp and Localized Aqueous Solution Miniature Ferris wheel are in satisfactory level with an average of 84.19 and 79.50, respectively. This means that students at this level have developed the fundamental knowledge and skills and core understanding, and with little guidance from the teacher and/or with some assistance from peer, and can transfer these understanding through authentic performance task (DepEd Order No. 8, s 2015).

On the other hand, Localized aqueous solution mini fan is in *fairly satisfactory* level with an average of 78.06. This means that students at this level possess the minimum knowledge and skills and core understandings, but need help throughout the performance of authentic task (DepEd Order No. 8, s 2015).

The result of the post-test implies that the utilization of the localized apparatuses has contributed to the students' understanding of the concept. Moreover, the application of such activity marks an improvement on the retention of the students' knowledge on electrical conductivity. Evidently, the students have acquired and developed comprehension on the concept.

The study of Mboto, Udo and Stephen (2011) on the effects of improvised materials on students' achievement and retention of the concept of radioactivity has similar result to the present study. The study found out that improvised materials greatly helped students remember Science concepts better than the traditional teaching.

Table 3. Difference between the Pre-test and Post-test Performance of the Students

Group of Students Under Localized Aqueous…	Pre-Test	Post-test	Diff.	Comp. t	p-value	Decision	Remark
Solution Lamp	67.26	84.19	16.93	10.758	0.000	Reject H_o	Significant
Mini Fan	68.39	78.06	9.67	5.677	0.000	Reject H_o	Significant
Miniature Ferris Wheel	67.91	79.50	11.59	7.163	0.000	Reject H_o	Significant

Level of significance = 0.05

Table 3 reveals that there is a difference in the pre-test and post-test performances of the students before and after the utilization of the 3 localized apparatuses. To test the data statistically, t-test for dependent data is applied. It is reflected that all p-values are less than the level of significance (0.05). This result is sufficient evidence to reject the null hypothesis. This means that a significant difference occurs between the pretest and post-test performances of the students in favor of the latter performance. This signifies that the utilization of the different localized apparatuses enables the students to obtain the concepts of electrical conductivity of aqueous solutions that made them obtain higher scores in the posttest.

The result of the present study supports to the study of Ugbe and Dike (2012). The said study reveals that there is a significant difference between the students who are taught with the use of improvised apparatuses and those who are taught with bomb calorimeter. The conclusion in favors the improvised apparatus. Ahmed (2008) also confirms that, there is a significant difference among the post-test and pre-test of the students after the localized apparatuses have been introduced. The result shows that the students performed better after the localized apparatuses have been introduced. In addition the study also revealed that students learn more and can grasp more information when materials used are familiar to them.

However, the study of Onasanya and Omosewo (2011) contradicts the current result, they reveal that students performance does not vary from those who are taught using improvised and those who are taught using standard materials.

Table 4. Difference among the Posttest Performances of the Students after the Utilization of the Localized Apparatuses

Group of Students Under Localized Aqueous…	Post-test	Comp. F	p-value	Decision	Remark
Solution Lamp	84.19				
Mini Fan	78.06	3.50	0.033	Reject H_o	Significant
Miniature Ferris Wheel	79.50				

Level of significance = 0.05

Table 4 displays the post-test performances of the students after the utilization of the localized apparatuses. As shown, their ratings vary. To test if significant difference exists among students' performances, ANOVA test is applied. It is reflected that the p-value (0.033) is less than the level of significance (0.05). This is enough evidence to reject the null hypothesis. This means that the performances of the 3 groups of students subjected to different localized apparatuses significantly differ. To identify which group or groups of students have better performance than the other group, the Post Hoc Analysis is utilized. The result is presented on Table 5.

Table 5. Post Hoc Analysis of the Posttest Performances of the Students after the Utilization of the Localized Apparatuses

Group of Students Under Localized Aqueous…	Post-test	p-value	Decision	Remark
Solution Lamp vs. Mini Fan	84.19 78.06	0.017	Reject H_o	Significant
Solution Lamp vs. Miniature Ferris Wheel	84.19 79.50	0.040	Reject H_o	Significant
Mini Fan vs. Miniature Ferris Wheel	78.06 79.50	0.588	Do not reject H_o	Not significant

Level of significance = 0.05

The result relates to the conclusion of Ahmed (2008) in the study on, Improvisation of instructional materials for the teaching of Biology, an important innovation in the Nigerian educational system, it reveals that there is a significant difference among the post- test performance of the students after the improvised instructional materials have been applied in the experiment.

The data signify that the use of localized aqueous solution lamp is better than the mini fan and miniature ferris wheel (both p-values < 0.05). While the localized aqueous mini fan is as good as miniature ferris wheel (p value > 0.05). The result unveils that the performances among students differ according to the different localized apparatuses introduced to them. It indicates that, although all the groups are introduced with localized apparatuses, their ability to interpret the learning, differ.

The data presented conform to the result of Aina (2013) on the study conducted on, “theInstructional Materials and Improvisation in Physics class: implications for Teaching and Learning”. The study reveals that there is difference on the performance of the students on the different improvised materials introduced. Moreover, Aina and Philip (2013) conclude that improvised materials stimulate the learner’s interest when effectively used.

Improvisation and localization means fabricating or creating new apparatuses with the use of materials that is readily available in the community (Santo, et.al, 1972). Localized apparatus are more realistic and relatable to students since the materials used are familiar and accessible; hence, it is doing more with less expense.

Table 6.

Extent of Perception of the Students on the Utilization of the Localized Apparatuses in Terms of Motivation

Indicators	Solution Lamp (n = 43)		Mini Fan (n = 33)		Miniature Ferris Wheel (n = 47)	
	$w\bar{x}$	VD	$w\bar{x}$	VD	$w\bar{x}$	VD
I am eager to attend class when electrical conductivity apparatus is used.	4.63	SA	4.55	SA	4.32	SA
I am motivated to take part to the experiment when there is localized apparatus.	3.81	A	4.45	SA	4.23	SA
I am not bored with the laboratory experiment and discussion throughout the learning period when localized apparatus is used	3.26	MA	3.85	A	3.55	A
I can focus my attention to the topic presented with the aid of localized apparatus.	4.07	A	4.15	A	4.26	SA
I am inspired to learn about the topic after it was presented using the materials available in my community.	3.47	A	4.67	SA	4.17	A
Composite	**3.85**	**A**	**4.33**	**SA**	**4.11**	**A**

Legend: Scale	Verbal Description	Extent of Perception
4.21 – 5.00	Strongly Agree (SA)	Very High (VH)
3.41 – 4.20	Agree (A)	High (H)
2.61 – 3.40	Moderately Agree (MA)	Moderate (M)
1.81 – 2.60	Disagree (D)	Low (L)
1.00 – 1.80	Strongly Disagree (SD)	Very Low (VL)

The data in table 6 revealthe perception of students on the utilization of the localized apparatuses in terms of motivation. It shows that the students have high perception in aqueous solution lamp and miniature Ferris wheel with a weighted mean of 3.85 and 4.11, respectively, which means that students agree on the indicators given and very high in mini fan with a weighted mean of 4.33,which means students strongly agree on the indicators. It indicates that students who are motivated are more excited to learn and actively participate in the teaching-learning process. The data have similar result on the study of Aina (2013), in the study on,“instructional Materials and Improvisation in Physics Class: Implications for Teaching and Learning”, it was observed that students enjoy or gain more when improvised materials were used for teaching physics.

Table 7.
Extent of Perception of the Students on the Utilization of the Localized Apparatuses in Terms of Cognition

Indicators	Solution Lamp (n = 43)		Mini Fan (n = 33)		Miniature Ferris Wheel (n = 47)	
	$w\bar{x}$	VD	$w\bar{x}$	VD	$w\bar{x}$	VD
Topics presented can easily be understood when localized apparatus is used in the activity.	4.60	SA	4.30	SA	3.96	A
My imagination on the concept presented is enhanced with the use of locally made apparatus.	4.09	A	4.03	A	3.72	A
I can visualize clearly the processes when locally made apparatus is used.	3.84	A	4.39	SA	4.15	A
I can describe the events after the experiments when the flow of the activity is aided with localized apparatus.	3.79	A	4.06	A	3.74	A
I can easily remember important/key points on the topic when localized apparatus is used in the experiment	4.37	SA	4.27	SA	4.26	SA
Composite	4.14	A	4.21	SA	3.97	A

Legend: Scale	Verbal Description		Extent of Perception	
4.21 – 5.00	Strongly Agree	(SA)	Very High	(VH)
3.41 – 4.20	Agree	(A)	High	(H)
2.61 – 3.40	Moderately Agree	(MA)	Moderate	(M)
1.81 – 2.60	Disagree	(D)	Low	(L)
1.00 – 1.80	Strongly Disagree	(SD)	Very Low	(VL)

The data reveal the perception of students on the utilization of the localized apparatuses in terms of cognition, high in aqueous solution lamp and miniature Ferris wheel with a weighted mean of 4.14 and 3.97, respectively. It indicates that students generally agree on the indicators listed. Very high in mini fan with a weighted mean of 4.21, this means that most of the students strongly agree on the listed indicators. It depicts that students who have high cognitive skills are able to reason out, think critically, and formulate conclusions and generalizations and retain the information they have learned.

The result conforms on the study of Ahmed (2008), it concludes that improvisation helps to develop student attitude towards Science and that this attitude can lead to more retention on Science lesson. Tomasello (2009) also concluded that cognition plays a key role in learners' ability to grasp information for it enables students acquire thinking skills and not just merely memorizing facts.

Table 8.
Extent of Perception of the Students on the Utilization of the Localized Apparatuses in Terms of Interaction

Indicators	Solution Lamp (n = 43)		Mini Fan (n = 33)		Miniature Ferris Wheel (n = 47)	
	$w\bar{x}$	VD	$w\bar{x}$	VD	$w\bar{x}$	VD
I can actively participate in the activity when locally made apparatus is used.	4.07	A	4.39	SA	4.17	A
I can easily share my observations with my classmates when locally made apparatus is used.	4.19	A	4.21	SA	4.15	A
I can easily understand and answer the guide questions when localized apparatus is used in the experiment.	4.10	A	4.06	A	3.91	A
I can raise questions about real life situation when localized apparatus is used in the discussion.	3.81	A	3.73	A	3.77	A
I can impart my opinions based on my experiences when localized apparatus is used.	3.98	A	4.09	A	4.55	SA
Composite	**4.03**	**A**	**4.10**	**A**	**4.11**	**A**

Legend: Scale	Verbal Description		Extent of Perception	
4.21 – 5.00	Strongly Agree	(SA)	Very High	(VH)
3.41 – 4.20	Agree	(A)	High	(H)
2.61 – 3.40	Moderately Agree	(MA)	Moderate	(M)
1.81 – 2.60	Disagree	(D)	Low	(L)
1.00 – 1.80	Strongly Disagree	(SD)	Very Low	(VL)

The data revealed the perception of students on the utilization of the localized apparatuses in terms of interaction, high in aqueous solution lamp with a weighted mean of 4.03, high in mini fan with a weighted mean of 4.10, and high in miniature Ferris wheel with a weighted mean of 4.11.This means that students agree on the indicators given in terms of interaction. Interaction triggers learners' involvement in the classroom discussion, it aids students' realization on the importance of the topic presented by the teacher (Chin, 2006). Hence, the data revealed that the more interaction occurs in the class discussion, the more learning will be achieved. The data presented has similar result of Aina (2013), which concludes that improvisation removes abstractions in learning because the products of improvisation are tangible, handy and concrete; hence, students are more active in the teaching-learning process.

Table 9.
Relationship between the Perception of the Students on the Utilization of the Localized Apparatuses and Their Post-Test Performance

Group of Students Under Localized Aqueous…	Solution Lamp (n = 43)	Mini Fan (n = 33)	Miniature Ferris Wheel (n = 47)
Motivation	r_s =0.017 p = 0.914 (not significant)	r_s = 0.496 p = 0.003 (significant)	r_s = 0.380 p = 0.008 (significant)
Cognition	r_s = 0.302 p = 0.049 (significant)	r_s = 0.353 p = 0.044 (significant)	r_s = 0.301 p = 0.040 (significant)
Interaction	r_s = 0.108 p = 0.401 (not significant)	r_s = 0.442 p = 0.010 (significant)	r_s = 0.344 p = 0.018 (significant)

Level of significance = 0.05

Legend:	Value of r	Strength of Relationship (Statistical Correlation, 2009)
Between	± 0.50 to ± 1.00	± strong relationship
Between	± 0.30 to ± 0.49	± moderate relationship
Between	± 0.10 to ± 0.29	± weak relationship
Between	± 0.01 to ± 0.09	± very weak relationship

The data reflect that students' perception in terms of cognition on the utilization of localized aqueous solution lamp and their posttest performance is significantly and moderately related ($p = 0.049 < \alpha = 0.05$). This means that the higher their perception on this area, the higher also is their post-test performance. From the data presented, the researcher concludes that students who have high cognition have higher retention and understanding on the lesson. Thus, through the aid of localized apparatuses students are able to acquire thinking skills rather than just merely memorizing facts.

This result runs parallel on the study of Kelly, Brown and Crawford (2000), which concludes that improvisation develops students to make interpretations, offer elucidations, make suggestions, and follow the logical consequences of their decisions.

Meanwhile, in terms of motivation and interaction, in the utilization of aqueous solution lamp, the data reveal that their p-values are greater than the level of significance (0.05). Thus, the null hypothesis is not rejected. This means that whether they have high or low perception on these areas, their post-test performance is more or less the same. Further, the result depicts that students' motivation and interaction when aided with localized aqueous solution lamp does not differ; hence, the performance of the students does not changed.

Furthermore, the data connote that students' perception in terms of motivation, cognition and interaction on the utilization of localized aqueous mini fan and their post-test performance is significantly and moderately related (all p-values $< \alpha = 0.05$). This means that the students with higher perception on these areas tend to obtain better post-test performance. Moreover, the data conclude that the utilization of localized aqueous solution mini fan enhanced the students' eagerness to learn, enthusiasm in participating the activity and keenness in formulating generalization.

The data concord with the result of Bhukuvhani, et. al. (2010), which disclose that improvisation develops conceptual understanding in Science and that students enjoy experimentation by using locally made equipment.

Moreover, the data display that students' perception in terms of motivation, cognition and interaction on the utilization of localized aqueous miniature ferris wheel and their post-test performance is significantly and moderately related (all p-values < α = 0.05). This means that their perception on these areas can moderately predict their post-test performance. Also, the result indicates that the utilization of localized aqueous solution Ferris wheel in the discussion affects students' determination to learn, ability to grasp information and capacity to deliberate ideas.

The above mentioned result is in line with the conclusion of Jurow, and Creighton (2005), as they unveil that through improvising, students can take part and view Science as comprehensive, inspiring, and open-ended subject. They conclude that the use of improvised equipment enable students to actively involvein the discussion.

Summary of Findings

Presented here are the results, based on the analysis and interpretation of the gathered data.

1. **Pre-test performance of the students on electrical conductivity of aqueous solution.**

The data show the pre-test performance of the students before localized apparatuses have been utilized in the experiment.

1.1. 67.26% (localized aqueous solution lamp);

1.2. 68.39% (localized aqueous solution mini fan); and

1.3. 67.91% (localized aqueous solution Ferris wheel).

2. **Post-test performance of the students about the concept of electrical conductivity.**

The data present the post-test performance of the students after the localized apparatuses have been utilized.

2.1. 84.19% (localized aqueous solution lamp);

2.2. 78.06% (localized aqueous solution mini fan); and
2.3. 79.50 (localized aqueous solution Ferris wheel).

3. **Difference in the pre-test and post-test performance of the students.**

The data reveal that there is a significant difference between pretest and post-test performances of students on the following localized apparatuses:

3.1. Localized aqueous solution lamp with a difference of 16.93 on their performance and p- value of 0.000.

3.2. Localized aqueous solution mini fan with a difference of 9.67on their performance and p- value of 0.000.

3.3. Localized aqueous solution Ferris wheel with a difference of 11.59 on their performance and p- value of 0.000.

4. **Difference on the post-test performance of the students.**

The data unveils that there is a significant difference among the different sections introduced by localized apparatuses. The p-values (0.033) in all localized apparatuses using ANOVA test are less than the significance value (0.05). This is enough evidence to reject the null hypothesis. This means that the performances of the 3 groups of students subjected to different localized apparatuses significantly differ.

Study further reveal that the use of localized aqueous solution lamp is better than mini fan and miniature ferris wheel (both p-values < 0.05). While the localized aqueous mini fan is as good as miniature ferris wheel (p value > 0.05).

5. **Perception of the students on the utilization of the localized apparatuses.**

The data indicate the following extent of perception among students when localized apparatuses have been utilized.

5.1. Motivation

a. Localized aqueous solution lamp: $w\bar{x}$ = 3.85 (high);
b. Localized aqueous mini fan: $w\bar{x}$ = 4.33 (very high); and,
c. Localized aqueous Ferris wheel: $w\bar{x}$ = 4.11 (high).

5.2. Cognition

a. Localized aqueous solution lamp: $w\bar{x}$ = 4.14 (high);
b. Localized aqueous mini fan: $w\bar{x}$ = 4.21 (very high); and,
c. Localized aqueous Ferris wheel: $w\bar{x}$ = 3.97 (high).

5.3. Interaction

a. Localized aqueous solution lamp: $w\bar{x}$ = 4.03 (high);
b. Localized aqueous mini fan: $w\bar{x}$ = 4.10 (very high); and,
c. Localized aqueous Ferris wheel: $w\bar{x}$ = 4.11 (high).

6. **Relationship between the perception of the students on the utilization of the localized apparatuses and their post-test performance**

The data manifest the following degrees of relationship:

6.1. Motivation

a. Localized aqueous solution lamp: r_s = 0.017 (weak);
b. Localized aqueous mini fan: ,r_s =0.496 (moderate); and
c.Localized aqueous Ferris wheel: r_s =0.380 (moderate).

6.2. Cognition

a. Localized aqueous solution lamp: r_s = 0.302 (moderate);
b. Localized aqueous mini fan: ,r_s =0.353 (moderate); and
c.Localized aqueous Ferris wheel: r_s =0.380 (moderate).

6.3. Interaction

a. Localized aqueous solution lamp: r_s = 0.108 (moderate);
b. Localized aqueous mini fan: ,r_s =0.442 (moderate); and
c.Localized aqueous Ferris wheel: r_s =0.344 (moderate).

Conclusions

The following conclusions are drawn based on the findings of the study:

1. The pre-test performance of the students in the concept of electrical conductivity of aqueous solution does not meet expectation.
2. The post-test performance of the students in the same concept after the localized apparatuses have been utilized is generally in the satisfactory level.
3. There is a significant difference between the pre-test and post-test performances of the students when localized apparatuses have been utilized. The increase in their post-test performances maybe attributed from the utilization of different localized apparatuses.
4. There is a significant difference among the post-test performances of the students on the concept introduced using localized apparatuses. The localized apparatuses have different effects on students. Among the three apparatuses aqueous solution lamp has better effect on students' academic performance. While the localized aqueous mini fan is as good as miniature ferris wheel.
5. The students' extent of perception of localized apparatuses is high in terms of motivation and cognition in miniature Ferris wheel and lamp, and very high in mini fan. While high in terms of interaction are all the localized apparatuses.
6. The relationship between the perceptions of the students is weak in terms of motivation and interaction in aqueous solution lamp and moderate in mini fan and miniature Ferris wheel. While moderate in terms of cognition, in all of three apparatuses.

Generally, the students have gained better understanding on the concept of electrical conductivity of aqueous solution through utilizing localized apparatuses in the activity.

Recommendations

In the light of the findings and conclusions drawn, the following are recommended:

1. The Department of Education may conduct a seminar and workshops among Science teachers about planning, designing and implementing the utilization of locally made apparatuses, in which materials are readily available in the community of the school for the development of students' performances in Science in order to cater the needs of laboratory apparatuses in public schools.
2. Science teachers engage students more on activities and experiments to enhance their knowledge and skills in applying scientific method, which will also be helpful in real life situation.
3. Teachers embrace the use of localized materials in the teaching-learning process so as to bring the lesson closer and more relatable to the students, for them to grasp the lesson and acquire retention on the concepts.
4. The study may be replicated in other Science concept to confirm the aforementioned findings.

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Appendices

Electrical Conductivity

Pre-test

Name: ________________________ School: _____________

Grade& Section: ______________ Date:______________

Instruction: The test consists of 30 questions totally, and each question has only one correct answer. Please finish all the questions on your own. Encircle the letter of the correct answer. Please avoid erasures.

1. Solutions that conduct electricity are called _____.
   A. Electrolytes
   B. Conductors
   C. Insulators
   D. Non-electrolytes
2. Which of the following statements is **TRUE?**
   A. Solutions can conduct electricity if there are uncharged particles present.
   B. Solutions cannot conduct electricity if there are charged particles present.
   C. Solutions can conduct electricity if there are charged particles present.
   D. Solutions can conduct electricity if there are non-electrolytes present.
3. Which of the following are electrically conductive?
   A. Non-metals
   B. Metals
   C. Carbohydrates
   D. Pure water
4. Electricity may be produced through ____________ occurring in a solution.
   A. Chemical change
   B. Physical change
   C. No change
   D. Any change
5. In which of the following compound does electricity conduct?
   A. Salt
   B. Sugar
   C. Paraffin wax
   D. Alcohol
6. The chemical attractions between atoms in a molecule are referred to as _______.
   A. Intramolecular forces
   B. Intermolecular forces
   C. Both and b
   D. None of these
7. The chemical bonds that are formed or broken when a substance participates in a chemical reaction.
   A. Intramolecular bond
   B. Intermolecular bond
   C. Chemical bond
   D. None of these
8. For a substance to be electrically conductive, there must be _________.
   A. Either loose electrons or loose ions.
   B. Either gain electrons or gain ions.
   C. Either gain electrons or loose ions.
   D. Either loose electrons or gain ions.
9. An electrostatic attraction between two oppositely charged ions is called________.
   A. Intramolecular bond
   B. Ionic bond
   C. Intermolecular bond
   D. Double bond
10. Which of the following best describe why Calcium carbonate ($CaCO_3$) is a strong electrolyte?
    A. the $CaCO_3$ can't dissolve in aqueous solution
    B. the $CaCO_3$ completely ionizes when melted
    C. the $CaCO_3$only partially ionizes in aqueous solution
    D. the $CaCO_3$ does not dissociate in aqueous solution
11. The potassium bromide (KBr) aqueous solution can make the bulb light on. The substance(s) that caused electrical conductivity is (are)______.
    A. water
    B. K^+ and Br^-
    C. solute
    D. Potassium
12. The conductivity of carbonic acid (H_2CO_3) solution is weaker than sulfuric acid (H_2SO_4) solution, thus H_2CO_3 is a weak electrolyte. This is due to the fact that________.
    A. weak conductivity is not necessary to weak electrolyte
    B. H_2CO_3 solution has molecules, molecules are not conductive
    C. H_2CO_3 is a weak acid, only H^+ is conductive
    D. H_2CO_3 is a weak acid, only COis conductive

13. What particles exist when magnesium chloride ($MgCl_2$) is heated into the melt state?
    A. Mg_2^+ and Cl^-
    B. $MgCl_2$ molecules
    C. water and $MgCl_2$ molecules
    D. particles will be vanished
14. Pure water has very weak electrical conductivity. How the rare ions are produced in water?
    A. The interactions are broken in water molecules
    B. Single water molecule ionized automatically
    C. By electricity
    D. There are no ions produced in water

15. The reason for the answer of Q14 is___________.
    A. there are interactions among water molecules
    B. molecules ionized by electricity
    C. weak electrolyte only partially ionized
    D. There are no ions produced in water

16. The electrical conductivity of HCl solution is_____ than (as) HClO solution with the same concentration.
    A. the same
    B. weaker
    C. stronger
    D. slightly weaker
17. The reason for the answer of Q16 is that_________.
    A. the concentrations of two solutions are the same
    B. the more ions exist in HCl solution
    C. the conductivity of strong acid is stronger
    D. none of these
18. One aqueous solution contains barium ion, another contains sulfate ion. When mixing the two solutions together, you will see barium sulphate precipitated. The barium sulphate is_______.
    A. a strong electrolyte
    B. a weak electrolyte
    C. a non-electrolyte
    D. a slightly weak electrolyte
19. Formic acid is a weak electrolyte, and there are few HCOO- and H+ in aqueous solution. How the ions are produced?
    A. Few HCOOH molecules ionized automatically
    B. The interactions in formic acid were broken by water molecule
    C. There are ions in all electrolyte aqueous solution
    D. None of these
20. Which of the following best describe strong electrolytes?
    I. solution/solute that completely ionizes in a solution
    II. when in aqueous solution, it is a good conductor of electricity
    III. it includes salts
    A. I only
    B. III only
    C. I, II and III
    D. I and II
21. The chemical change caused by the passage of an electric current through a solution of an electrolyte is called_________.
    A. Electronic change
    B. Electrical change
    C. Current change
    D. Electrolysis
22. Sodium hydroxide almost completely dissociate in aqueous solution. Therefore, sodium hydroxide is a ________.
    A. Weak electrolyte
    B. Slightly weak electrolyte
    C. Non-electrolyte
    D. Strong electrolyte
23. Which of the following best describe Potassium chloride?
    A. It is a weak electrolyte
    B. It does not completely dissociate in an aqueous solution.
    C. It is a non-electrolyte
    D. It is a strong electrolyte
24. Ammonia is partially dissociated in a fused aqueous solution. Therefore, Ammonia is a __________.
    A. Strong electrolyte
    B. Slightly strong electrolyte
    C. Weak electrolyte
    D. Non-electrolyte
25. Which of the following best describe weak electrolyte?
    A. They are good conductor

B. They are partially dissociated in an aqueous solution
C. The solution contains only free mobile ions
D. They allow electricity to flow

26. Which of the following best describe strong electrolyte?
A. They do not allow electricity to flow
B. They are poor conductor
C. They completely dissociate in an aqueous solution
D. They allow a bulb to glow dimly

27. Sodium chloride is an ionic compound, it is composed of the interaction of sodium and chlorine and it is a strong electrolyte. Which of the following best explain why sodium chloride is a strong electrolyte?
A. It can allow a light bulb glow dimly.
B. It is an ionic compound
C. It has sodium
D. It will completely dissociate in an aqueous solution

28. Which of the following samples are strong electrical conductors?
A. Sodium chloride, ammonia, benzoic acid
B. Ethanol, benzene, urea
C. Hydrogen chloride, carbonic acid, oxalic acid
D. Sodium chloride, hydrogen chloride, nitric acid

29. Which of the following substances when dissolved in water will conduct electricity?
A. Glucose
B. Oil
C. Gasoline
D. Monosodium glutamate

30. Which of the following substance cannot conduct electricity even if dissolved in water?
A. Alcohol
B. Salt
C. Vetsin
D. Sulfuric acid

Electrical Conductivity
Post-test

Name: ______________________ School: ____________
Grade& Section: ____________ Date:____________

Instruction: The test consists of 20 questions totally, and each question has only one correct answer. Please finish all the questions on your own. Encircle the letter of the correct answer. Please avoid erasures.

1. Solutions that conduct electricity are called ____.
A. Electrolytes
B. Conductors
C. Insulators
D. Non-electrolytes

2. Which of the following statements is **TRUE?**
A. Solutions can conduct electricity if there are uncharged particles present.
B. Solutions cannot conduct electricity if there are charged particles present.
C. Solutions can conduct electricity if there are charged particles present.
D. Solutions can conduct electricity if there are non-electrolytes present.

3. Which of the following are electrically conductive?
A. Non-metals
B. Metals
C. Carbohydrates
D. Pure water

4. Electricity may be produced through __________ occurring in a solution.
A. Chemical change
B. Physical change
C. No change
D. Any change

5. In which of the following compound does electricity conduct?
A. Salt
B. Sugar
C. Paraffin wax
D. Alcohol

6. The chemical attractions between atoms in a molecule are referred to as ______.
A. Intramolecular forces
B. Intermolecular forces
C. Both and b
D. None of these

7. The chemical bonds that are formed or broken when a substance participates in a chemical reaction.
   A. Intramolecular bond
   B. Intermolecular bond
   C. Chemical bond
   D. None of these
8. For a substance to be electrically conductive, there must be _________.
   A. Either loose electrons or loose ions.
   B. Either gain electrons or gain ions.
   C. Either gain electrons or loose ions.
   D. Either loose electrons or gain ions.
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    A. water
    B. K^+ and Br^-
    C. solute
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    A. weak conductivity is not necessary to weak electrolyte
    B. H_2CO_3 solution has molecules, molecules are not conductive
    C. H_2CO_3 is a weak acid, only H^+ is conductive
    D. H_2CO_3 is a weak acid, only COis conductive
13. What particles exist when magnesium chloride ($MgCl_2$) is heated into the melt state?
    A. Mg_2^+ and Cl^-
    B. $MgCl_2$ molecules
    C. water and $MgCl_2$ molecules
    D. particles will be vanished
14. Pure water has very weak electrical conductivity. How the rare ions are produced in water?
    A. The interactions are broken in water molecules
    B. Single water molecule ionized automatically
    C. By electricity
    D. There are no ions produced in water
15. The reason for the answer of Q14 is___________.
    A. there are interactions among water molecules
    B. molecules ionized by electricity
    C. weak electrolyte only partially ionized
    D. There are no ions produced in water
16. The electrical conductivity of HCl solution is_____ than (as) HClO solution with the same concentration.
    A. the same
    B. weaker
    C. stronger
    D. slightly weaker
17. The reason for the answer of Q16 is that_________.
    A. the concentrations of two solutions are the same
    B. the more ions exist in HCl solution
    C. the conductivity of strong acid is stronger
    D. none of these
18. One aqueous solution contains barium ion, another contains sulfate ion. When mixing the two solutions together, you will see barium sulphate precipitated. The barium sulphate is_______.
    A. a strong electrolyte
    B. a weak electrolyte
    C. a non-electrolyte
    D. a slightly weak electrolyte
19. Formic acid is a weak electrolyte, and there are few HCOO- and H+ in aqueous solution. How the ions are produced?
    A. Few HCOOH molecules ionized automatically
    B. The interactions in formic acid were broken by water molecule
    C. There are ions in all electrolyte aqueous solution

D. None of these

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    I. solution/solute that completely ionizes in a solution
    II. when in aqueous solution, it is a good conductor of electricity
    III. it includes salts

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B. III only
C. I, II and III
D. I and II

21. The chemical change caused by the passage of an electric current through a solution of an electrolyte is called_________.

A. Electronic change
B. Electrical change
C. Current change
D. Electrolysis

22. Sodium hydroxide almost completely dissociate in aqueous solution. Therefore, sodium hydroxide is a ________.

A. Weak electrolyte
B. Slightly weak electrolyte
C. Non-electrolyte
D. Strong electrolyte

23. Which of the following best describe Potassium chloride?

A. It is a weak electrolyte
B. It does not completely dissociate in an aqueous solution.
C. It is a non-electrolyte
D. It is a strong electrolyte

24. Ammonia is partially dissociated in a fused aqueous solution. Therefore, Ammonia is a __________.

A. Strong electrolyte
B. Slightly strong electrolyte
C. Weak electrolyte
D. Non-electrolyte

25. Which of the following best describe weak electrolyte?

A. They are good conductor
B. They are partially dissociated in an aqueous solution
C. The solution contains only free mobile ions
D. They allow electricity to flow

26. Which of the following best describe strong electrolyte?

A. They do not allow electricity to flow
B. They are poor conductor
C. They completely dissociate in an aqueous solution
D. They allow a bulb to glow dimly

27. Sodium chloride is an ionic compound, it is composed of the interaction of sodium and chlorine and it is a strong electrolyte. Which of the following best explain why sodium chloride is a strong electrolyte?

A. It can allow a light bulb glow dimly.
B. It is an ionic compound
C. It has sodium
D. It will completely dissociate in an aqueous solution

28. Which of the following samples are strong electrical conductors?

A. Sodium chloride, ammonia, benzoic acid
B. Ethanol, benzene, urea
C. Hydrogen chloride, carbonic acid, oxalic acid
D. Sodium chloride, hydrogen chloride, nitric acid

29. Which of the following substances when dissolved in water will conduct electricity?

A. Glucose
B. Oil
C. Gasoline
D. Monosodium glutamate

30. Which of the following substance cannot conduct electricity even if dissolved in water?

A. Alcohol
B. Salt
C. Vetsin
D. Sulfuric acid

Key to Correction (Pre- Test)

1. A	11. B	21. D
2. C	12. B	22. D
3. B	13. A	23. D
4. B	14. A	24. C
5. A	15. A	25. B
6. A	16. C	26. C
7. A	17. B	27. D
8. A	18. A	28. D
9. B	19. B	29. D
10. B	20. C	30. A

Key to Correction (Post- Test)

1. A	11. B	21. D
2. C	12. B	22. D
3. B	13. A	23. D
4. B	14. A	24. C
5. A	15. A	25. B
6. A	16. C	26. C
7. A	17. B	27. D
8. A	18. A	28. D
9. B	19. B	29. D
10. B	20. C	30. A

Survey Questionnaire

Localized Apparatuses in Teaching Electrical Conductivity of Aqueous Solutions

This questionnaire aims to identify the student's perception towards the use of localized apparatus in teaching electrical conductivity of aqueous solutions. Please answer the questions honestly. Rest assured that the information you shared is confidential. Thank you very much.

Name: ________________________ Grade and Section: __________________ Localized Apparatus used: __________________

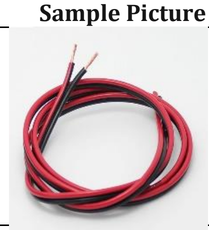
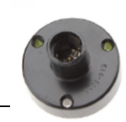
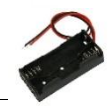
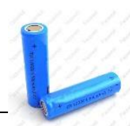
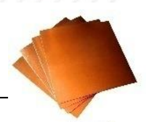
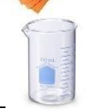
Instruction: Using the scale below please check the appropriate column as the way you perceive for the use of locally made apparatus in the science lesson, electrical conductivity of aqueous solutions.

Verbal description	**Extent of Perception**	**Explanation**
Strongly Agree	Very High	The feeling/behavior is felt/manifested by the students 100% of the time.
Agree	High	The feeling/behavior is felt/manifested by the students 80% of the time
Moderately Agree	Moderate	The feeling/behavior is felt/manifested by the students 60% of the time.
Disagree	Low	The feeling/behavior is felt/manifested by the students 40% of the time.
Strongly Disagree	Very Low	The feeling/behavior is felt/manifested by the students 1% of the time.

	Students' Perception	Strongly Agree (5)	Agree (4)	Moderately Agree (3)	Disagree (2)	Strongly Disagree (1)
	A. Learner's Motivation					
1.	I am eager to attend class when electrical conductivity apparatus is used.					
2.	I am motivated to take part to the experiment when there is localized apparatus.					
3.	I am not bored with the laboratory experiment and discussion throughout the learning period when localized apparatus is used					
4.	I can focus my attention to the topic presented with the aid of localized apparatus.					
5.	I am inspired to learn about the topic after it was presented using the materials available in my community.					
	B. Learner's Cognition					
6.	Topics presented can easily be understood when localized apparatus is used in the activity.					
7.	My imagination on the concept presented is enhanced with the use of locally made apparatus.					
8.	I can visualize clearly the processes when locally made apparatus is used.					
9.	I can describe the events after the experiments when the flow of the activity is aided with localized apparatus.					
10.	I can easily remember important/key points on the topic when localized apparatus is used in the experiment					
	C. Interaction					
11.	I can actively participate in the activity when locally made apparatus is used.					
12.	I can easily share my observations with my classmates when locally made apparatus is used.					
13.	I can easily understand and answer the guide questions when localized apparatus is used in the experiment.					
14.	I can raise questions about real life situation when localized apparatus is used in the discussion.					
15.	I can impart my opinions based on my experiences when localized apparatus is used.					

Construction Guide
Improvised Aqueous Solution Lamp

I. Materials

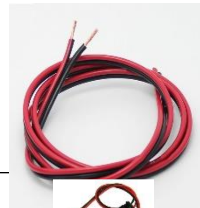
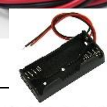
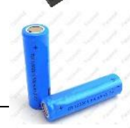
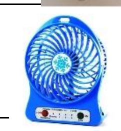
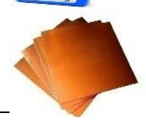
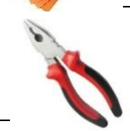
Materials	Sample Picture	Quantity	Specification
Red copper wire		1	10 inches 20 gauge
black copper wire		1	18 inches 20 gauge
LED bulb		1	14 E, 3.5watts
Socket		1	14 E
Battery case		1	1.5V AA battery
Battery			3.7 volts
Copper sheet		2	1"x1"
beaker		1	150 ml1
Pliers		1	

II. Procedure

1. Prepare all materials needed.
2. Connect the 10 inches red copper wire to one end of the battery holder's wire. Then, cut the black wire into 9 inches. Connect one of the 5 inches black wire to the batter holder's wire. Consider the color of the wires in connecting.
3. Next, attach the red wire to one of the socket's terminal.
4. After which, attach the other 9 inches black wire to the other terminal of the socket.
5. Then, peel the black wire's end (the wire being attached to the battery case) and bind it to the copper sheet. Do the same to the other black wire (the wire being attached to the socket).
6. Now place the batteries in the battery case. Consider the polarity in doing so.
7. Finally, place both of the wires with copper sheet to your container. Now your improvised aqueous solution lamp is ready for testing conductivity.
8. You can add designs and any artistic features for your aqueous solution lamp.

Construction Guide
Improvised Aqueous Solution Mini Fan

I. Materials:

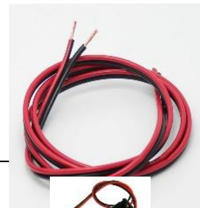
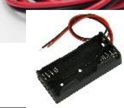
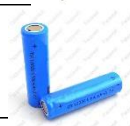
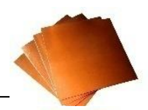
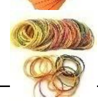
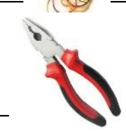
Materials	Sample Picture	Quantity	Specification
Red copper Wire		1	10 inches 20 gauge
Black copper wire		1	18 inches 20 gauge
Battery holder		1	3.7 volts
battery		2	3.7 volts
Dynamo		1	4 volts
Mini fan		1	Non-functioning
Copper sheet		2	1”x1”
Pliers			

II. Procedure

1. Prepare all materials needed.
2. Connect the 10 inches red copper wire to one end of the battery holder’s wire. Then, cut the black wire into 9 inches. Connect one of the 9 inches black wire to the battery holder’s wire. Consider the color of the wires in connecting.
3. Next attach the red wire to one of the dynamo’s terminal. Then attach the other 9 inches black copper wire to the other terminal.
4. Afterwards, peel the black wire’s end (the wire being attached to the battery case) and bind it to the copper sheet. Do the same to the other black wire (the wire being attached to the dynamo).
5. Now, disassemble the mini fan, detach the parts that will not be used. Get only the blades and the case.
6. Attach the blades to the dynamo, and return it back to the case.
7. Place your batteries in your battery case. Consider the polarity in doing so.
8. Then place the wires with copper sheets in your container. Finally, your improvised mini fan is ready to test the conductivity of your solutions.
9. Instead of mini fan case, you can make your own case and any designs you like.

Construction Guide
Aqueous Solution Miniature Ferris Wheel

I. Materials:

Materials	Sample Picture	Quantity	Specification
Red copper Wire		1	10 inches 20 gauge
Black copper wire		1	18 inches 20 gauge
Battery holder		1	3.7 volts
battery		2	3.7 volts
Dynamo		1	4 volts
Copper sheet		2	1”x1”
Rubber band		1	
Pliers			
‘Diy” miniature wheel			

II. Procedure

1. Prepare all materials needed. Prepare your “diy” miniature Ferris wheel ahead of time.
2. Connect the 10 inches red copper wire to one end of the battery holder’s wire. Then, cut the black wire into 9 inches. Connect one of the 9 inches black wire to the battery holder’s wire. Consider the color of the wires in connecting.
3. Next attach the red wire to one of the dynamo’s terminal. Then attach the other 9 inches black copper wire to the other terminal.
4. Afterwards, peel the black wire’s end (the wire being attached to the battery case) and bind it to the copper sheet. Do the same to the other black wire (the wire being attached to the dynamo).
5. Get you “diy” miniature Ferris wheel.
6. Through your rubber band connect the dynamo to your miniature Ferris wheel’s roller.
7. Place your batteries in your battery case. Consider the polarity in doing so.
8. Then place the wires with copper sheets in your container. Finally, your miniature Ferris wheel is ready to test the conductivity of your solutions.
9. Make your miniature Ferris wheel attractive by shinning out your creativity.

Construction Guide
Miniature Ferris Wheel

I. Materials

Materials	Quantity	Specification
Card board	1	½ m
Compass	1	
Pencil	1	Any number
Cutter	1	Any size
Barbeque sticks	10	10 inches
Candle glue	5	Any size
Glue gun		Same size with your candle glue
Balloon stick	1	5 inches
Popsicle sticks	20	
Jelly Ace cup	20	
Straw	5	
Lollipop sticks	10	2.5 inches
Wooden sticks	6	8 inches
Wooden block	4	1”x1”x.5”
Thread roll	1	
Scissors		

II. Procedure

1. Prepare all materials needed.
2. Using your compass draw a 2 same size circle on your card board (NOTE: the circle must be enough for your 10 pcs Barbeque sticks). Then find the center of your circles. Make a hole at the center, make sure that the whole will perfectly fit on your balloon stick.
3. Attach the end of the barbeque sticks around the circles, the distance between each barbeque sticks and its length must me the same. Use the other circle to cover your barbeque sticks being attached. Note: make sure that your balloon stick will fit through the two circles.
4. Cut your Popsicle sticks with a measurement of one inch. Then attach it in every end of the barbeque sticks. Then will serve as connector of your Popsicle sticks.
5. Get another popsicle stick then attach one end of the popsicle to your one-inch sticks then attach the other end to the other side. Do the same until you completely attached the popsicle sticks forming decagon.
6. Repeat procedure 2 to 5. Two pieces of decagon shaped sticks are needed.
7. Connect your 2 decagon shaped sticks using your balloon sticks.
8. Then for your cabin, get 2 jelly ace cups, glue it from one opening to the other. Make 10 finish products.
9. Cut the straw into 2.5 inches then attach it to the top part of your cabin/ jelly ace cup.
10. Attach your lollipop stick in every side of the decagon.
11. Insert each cabin in each lollipop sticks trough inserting the straws.
12. Now, attach the other decagon shaped sticks to the “almost done” miniature Ferris wheel. Secure it using stick glue.
13. For the leg support, make a triangle shaped leg by attaching the wooden sticks using stick glue. Then adhere the tread roll to the top vertex of your wooden triangle. After that, glue the wooden block in every side of the miniature Ferris wheel leg.
14. Next, make another circle, 3 pairs with the same size in every pair. Making this two 10cm diameter, two 8cm diameter and two 6cm diameter circles. Make hole in each circle that will fit through the balloon sticks.
15. Now, insert the circles in the balloon sticks starting from the biggest to the smallest.
16. Finally, your miniature Ferris wheel is ready all you need is a DC motor and a battery for this to work.

Laboratory Manual
Identifying Electrical Conductivity through Improvised Aqueous SolutionLamp

I. Introduction

The ability of a solution to allow electric current to flow is called electrical conductivity. It is based on the flow of electrons present in the solution. Good conductors like metals allow electrons to flow in the whole part, hence electrons flow like a bed of electrons. In contrast, very poor electrical conductor like distilled water slightly or does not allow electrons to flow. Highly ionized substance are strong electrolytes, examples of these are strong acids and salts, hence they completely dissociate in solution. The ions in it carry the electric charge through the solution creating an electric current.

Weak electrolytes are slightly ionized substances. Examples of this are weak acids and bases, they do not completely dissociate in solution.

Non-electrolytes are substances that do not conduct electric current. They do not ionize and they do not contain moveable ions.

In this activity you will be going to identify which among the substances given are electrolytes and non-electrolytes through the use of improvised salt-water lamp.

II. Objectives

At the end of the activity the students will be able to:

- Observe electrical conductivity of aqueous solution
- Identify other solutions that conduct electricity
- Determine if the solution is a strong or weak electrolyte
- Interpret a chemical reaction by observing aqueous solution conductivity.

III. Materials

- Improvised aqueous solution lamp
- Distilled water
- Tap water
- Sodium Chloride
- Citric Acid
- Monosodium glutamate
- Sucrose
- Calcium carbonate
- Wash Bottle
- Beaker
- Test Tubes
- Test Tube Rack

IV. Procedure

1. Prepare all the materials needed, specially your improvised apparatus.
2. Place 5 mL of *distilled* water into a small, clean beaker. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.
3. Place 5 mL of *tap water* into a small, clean beaker. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.
4. Place about 0.2 g of solid sodium chloride ($NaCl$) into a small, clean beaker. Add 5 mL distilled water to the sodium chloride. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.
5. Place about 3 mL of Citric acid into a small, clean beaker. Add 5 mL distilled water to the sodium chloride. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.
6. Place about 0.2g of monosodium glutamate into a small, clean beaker. Add 5 mL distilled water to the sodium chloride. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.

7. Place about 0.2 g of sucrose into a small, clean beaker. Add 5 mL distilled water to the sodium chloride. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.
8. Place about 0.2 g of calcium carbonate into a small, clean beaker. Add 5 mL distilled water to the sodium chloride. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.

V. Data and Observation

Solution	Observation	Conductivity	Strong/Weak or on- electrolyte	Ionized, Partially nized, or Non- ionized

VI. Guide Questions

1. Why is distilled water weak conductor than tap water?
2. What type of solution

   a. Dissolves easily?
   b. Conducts electricity in a solution?

3. Explain why NaCl and monosodium glutamate conducts electricity?
4. What are the common properties of

   a. Strong electrolytes
   b. Weak electrolytes
   c. Non- electrolytes

5. Why does solid sodium chloride act as a non-electrolyte while an aqueous while an aqueous NaCl solution acts as a strong electrolyte?

Laboratory Manual
Identifying Electrical Conductivity through Improvised Aqueous Solution Mini Fan

I. Introduction

The ability of a solution to allow electric current to flow is called electrical conductivity. It is based on the flow of electrons present in the solution. Good conductors like metals allow electrons to flow in the whole part, hence electrons flow like a bed of electrons. In contrast, very poor electrical conductor like distilled water slightly or does not allow electrons to flow. Highly ionized substance are strong electrolytes, examples of these are strong acids and salts, hence they completely dissociate in solution. The ions in it carry the electric charge through the solution creating an electric current.

Weak electrolytes are slightly ionized substances. Examples of this are weak acids and bases, they do not completely dissociate in solution.

Non-electrolytes are substances that do not conduct electric current. They do not ionize and they do not contain moveable ions.

In this activity you will be going to identify which among the substances given are electrolytes and non-electrolytes through the use of improvised salt-water Mini Fan.

II. Objectives

At the end of the activity the students will be able to:

- Observe electrical conductivity of aqueous solution
- Identify other solutions that conduct electricity
- Determine if the solution is a strong or weak electrolyte
- Interpret a chemical reaction by observing aqueous solution conductivity.

III. Materials

- Improvised aqueous solution mini fan
- Distilled water
- Tap water
- Sodium Chloride
- Citric Acid
- Monosodium glutamate
- Sucrose
- Calcium carbonate
- Wash Bottle
- Beaker
- Test Tubes
- Test Tube Rack

IV. Procedure

1. Prepare all the materials needed, specially your improvised apparatus.
2. Place 5 mL of *distilled* water into a small, clean beaker. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.
3. Place 5 mL of *tap water* into a small, clean beaker. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.
4. Place about 0.2 g of solid sodium chloride (NaCl) into a small, clean beaker. Add 5 mL distilled water to the sodium chloride. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.
5. Place about 3 mL of Citric acid into a small, clean beaker. Add 5 mL distilled water to the sodium chloride. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.
6. Place about 0.2g of monosodium glutamate into a small, clean beaker. Add 5 mL distilled water to the sodium chloride. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.
7. Place about 0.2 g of sucrose into a small, clean beaker. Add 5 mL distilled water to the sodium chloride. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.
8. Place about 0.2 g of calcium carbonate into a small, clean beaker. Add 5 mL distilled water to the sodium chloride. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.

V. Data and Observation

Solution	Observation	Conductivity	Strong/Weak or non-electrolyte	Ionized, Partially ionized, or Non-ionized

VI. Guide Questions

1. Why is distilled water weak conductor than tap water?
2. What type of solution

   c. Dissolves easily?
   d. Conducts electricity in a solution?

3. Explain why NaCl and monosodium glutamate conducts electricity?
4. What are the common properties of
   Strong electrolytes
   Weak electrolytes
   Non- electrolytes

5. Why does solid sodium chloride act as a non-electrolyte while an aqueous while an aqueous NaCl solution acts as a strong electrolyte?

Laboratory Manual
Identifying Electrical Conductivity through Improvised Aqueous Solution Miniature Ferris Wheel

I. Introduction

The ability of a solution to allow electric current to flow is called electrical conductivity. It is based on the flow of electrons present in the solution. Good conductors like metals allow electrons to flow in the whole part, hence electrons flow like a bed of electrons. In contrast, very poor electrical conductor like distilled water slightly or does not allow electrons to flow. Highly ionized substance are strong electrolytes, examples of these are strong acids and salts, hence they completely dissociate in solution. The ions in it carry the electric charge through the solution creating an electric current.

Weak electrolytes are slightly ionized substances. Examples of this are weak acids and bases, they do not completely dissociate in solution.

Non-electrolytes are substances that do not conduct electric current. They do not ionize and they do not contain moveable ions.

In this activity you will be going to identify which among the substances given are electrolytes and non-electrolytes through the use of improvised salt-water miniature Ferris wheel.

II. Objectives

At the end of the activity the students will be able to:

- Observe electrical conductivity of aqueous solution
- Identify other solutions that conduct electricity
- Determine if the solution is a strong or weak electrolyte
- Interpret a chemical reaction by observing aqueous solution conductivity.

III. Materials

- Improvised aqueous solution miniature Ferris wheel
- Distilled water
- Tap water
- Sodium Chloride
- Citric Acid
- Monosodium glutamate
- Sucrose
- Calcium carbonate
- Wash Bottle
- Beaker
- Test Tubes
- Test Tube Rack

IV. Procedure

1. Prepare all the materials needed, specially your improvised apparatus.
2. Place 5 mL of *distilled* water into a small, clean beaker. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.
3. Place 5 mL of *tap water* into a small, clean beaker. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.
4. Place about 0.2 g of solid sodium chloride (NaCl) into a small, clean beaker. Add 5 mL distilled water to the sodium chloride. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.
5. Place about 3 mL of Citric acid into a small, clean beaker. Add 5 mL distilled water to the sodium chloride. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.
6. Place about 0.2g of monosodium glutamate into a small, clean beaker. Add 5 mL distilled water to the sodium chloride. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.
7. Place about 0.2 g of sucrose into a small, clean beaker. Add 5 mL distilled water to the sodium chloride. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.
8. Place about 0.2 g of calcium carbonate into a small, clean beaker. Add 5 mL distilled water to the sodium chloride. Pour it in the glass container of your improvised electrical conductivity apparatus. Then test, observe and record your results.

V. Data and Observation

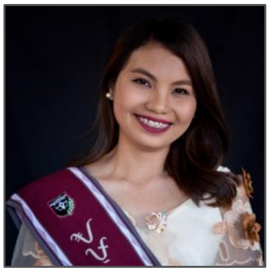
Solution	Observation	Conductivity	Strong/Weak or non-electrolyte	Ionized, Partially ionized, or Non-ionized

VII. Guide Questions

1. Why is distilled water weak conductor than tap water?
2. What type of solution
   Dissolves easily?
   Conducts electricity in a solution?

3. Explain why NaCl and monosodium glutamate conducts electricity?
4. What are the common properties of
   Strong electrolytes
   Weak electrolytes
   Non- electrolytes
5. Why does solid sodium chloride act as a non-electrolyte while an aqueous while an aqueous NaCl solution acts as a strong electrolyte?

AUTHOR'S PROFILE



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