Addressing the Poor Performance of Ghanaian Junior High School Pupils in selected science concepts through the use of Concepts Cartoons: A Study of Okai-Koi District, Accra

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Abstract

This study explored the use of concept cartoons to enhance the performance of Junior High School pupils in selected science concepts by using pre and post intervention test. Sample comprised 37 Junior High School pupils and one science teacher in Abelemkpe Junior High School in the Greater Accra Region of Ghana. Concept cartoons are instructional tools designed to generate scientific thinking among learners. Adapted to the 5E instructional model, they can be used at any stage of the learning process to facilitate effective learning of scientific concepts. Completed tests based on five selected science concepts were analyzed using the t-test inferential statistics to establish any significance difference between respondents' mean scores of the pre and post intervention data. Results revealed that the use of concept cartoons to teach the selected science concepts enhanced the pupils' cognitive achievement. The concept cartoons affected learners' academic achievement in positive ways. The pupils were able to construct their own knowledge and made meaning of their everyday experiences. Results of the t-test (t (36)=8.41, p=.000), (t (36)=9.38, p=.000), (t(36)=4.85, p=.000), (t(36)=10.58, p=.000) and (t(36)=11.85, p=.000) indicated a significant difference between the mean scores of the pretest and posttest. This implied that the use of concept cartoon had a positive effect on the cognitive achievement of pupils. It is therefore, recommended that JHS integrated science teachers adopt the use of concept cartoons to teach science effectively and to increase the pupils' motivation to learn science.

Key words: constructivist learning, concept cartoon, instructional strategy.

1. Introduction

Ghanaian JHS pupils' poor performance in science has been a subject of concern for quite some time now among various stakeholders (Eminah, 2007) with teachers bearing the brunt of the criticisms. JHS science teachers had, in the past, been accused of adopting the chalk and talk method of teaching Science with little or no practical activities resulting in the rote memorization of facts by the pupils (Parku, 2012). The JHS pupils found it difficult to understand concepts taught during science lessons because, apart from listening, they were not engaged in any hands- on activities. Parku also found that the learners were not encouraged to utilize the enquiry process of science to solve problems during practical activities simply because no practical activities were organized in the schools. Parku's observations are supported by comments made in reports of the Chief Examiner for Basic Education Certificate Examination (BECE) Science. He stated that the candidates' performance on the whole was poor (WAEC, 2015). Some of the candidates were unable to answer the questions and only copied them. Others who attempted to answer the questions provided incomplete answers. It appeared that the candidates were either not used to answering essay questions or were not taught how to go about answering such questions. The BECE science Chief Examiner asked for the intensification of science lessons and the discussion of marking scheme with the pupils. Additionally, the researcher's past experience as an Assistant Examiner for the BECE Science paper exposed her to the conceptual difficulties JHS pupils encountered in their final science paper. At the international level, BBC news reported in June 2015 that Ghana ranked last among 76 countries across the world in the then biggest ever global school rankings on Mathematics and Science (http://www.myjoyonline.com, 2015). This international assessment was the Trends in International Mathematics and Science Study (TIMSS) which, since 1995, has been organized every four years for 4th grade (basic 4) and 8th grade (JHS 2) pupils the world over.

The reasons why Ghanaian JHS pupils performed so poorly in this global science test are a cause for serious concern. At the local level, there are calls for reduction in the number of subjects studied by basic pupils so as to reduce the cognitive load on the learners. Other researchers such as Baure (2015) looked at the classroom transactions involving the pupils and their science teachers. He discovered that science teaching and learning were abstract with pupils less involved in the lesson. Encouraging as these research efforts were, the overall performance of JHS pupils in science has not shown any significant improvement, perhaps due to the fact that the real challenges facing JHS science were not addressed. The unanswered question is whether the real problems confronting JHS science teaching and learning in Ghana has been properly conceptualized for effective redress. JHS science teachers in most cases use the teacher centered approach to teach science due to the lack of teaching learning materials and science laboratory in most cases.
One instructional innovation which is new in the Ghanaian educational system and hence untested is the use of concept cartoons subsumed by the 5E instructional model (5E = engage, explore, explain, elaborate and evaluate). This instructional instrument is based on the constructivist learning theory. This study, therefore, was designed to find out the effect of concept cartoons on the performance of pupils in mixtures, heredity, osmosis, electrical circuit and diffusion at Abelemkpe Junior High School, Accra. The following research questions guided the study:

1. What are the causes of JHS pupils' poor performance over the years?
2. What is the effect of concept cartoons on JHS pupils' performance in selected integrated science concepts?

2. Review of Literature

Concept cartoons are cartoon style drawings designed as a stimulus to question, to intrigue, to provoke discussion and to generate scientific thinking among the learners. Concept cartoons provide a range of viewpoints and are based on the constructivist approach (Long & Marson, 2003). Concept cartoons can be used in different ways in educational settings. They are seen as tools that allow teachers to gain students' attention, visually focus them on the lesson and create an environment where students can construct or reconstruct their views on a certain topic (Balim, Inel, & Evrekli, 2008). These cartoons can be used at the beginning of a lesson to examine students' prior knowledge, reveal their thoughts and motivate them to discuss a certain concept (Balim, Inel, & Evrekli, 2008; Keogh, Naylor, & Downing, 2003; Kabapinar, 2005). The 5E instructional model, based on theories of constructivist teaching, is a sequence of stages teachers may go through with students to help them develop a conceptual understanding of concepts. This model enables students to go beyond what they can do independently. Every element of the five Es is carefully created to promote learners' construction of knowledge. The idea behind the model is to begin with students' current knowledge, make connections between current knowledge and new knowledge, provide direct instruction of ideas the students would not be able to discover on their own, and provide opportunities for them to demonstrate understanding (Bybee, Taylor, Gardner, Scotter, Powell, Westbrook & Landes, 2006). Similarly, concept cartoons can perform these functions. Concept cartoons feature cartoon-style drawings, which show different characters arguing about everyday situations and are designed to intrigue, provoke discussion and stimulate scientific thinking, and may not have a single so-called "right answer" (Keogh & Naylor, 1999). Research shows that the use of concept cartoons as a teaching approach is highly motivating across all age ranges including learners of different levels of understanding. It is also effective in both revealing and challenging learners' ideas, linking the process of elicitation and restructuring ideas and effective in integrating learning and assessment into a single strategy.

The use of concept cartoons stimulate thinking among learners which enable them to construct their own knowledge, since the cartoons do not necessarily have a single correct answer (Martinez, 2004). Therefore, the use of dialogues creates opportunities for learners to present alternative ideas, including scientifically valid views (Keogh & Naylor, 1999).

Apart from being an effective teaching strategy, concept cartoons are effective assessment tools in finding out students' alternative ideas (İngeç, 2008; İngeç, Yıldız & Ünlü, 2006; Naylor, S, Keogh, B., de Boo, M., & Feasey, R. 2001; Pelaez, Hoover & Treagust, 2004). Long and Marson (2003) summarized the benefits of concept cartoons in the following manner. They noted that concept cartoons:

- help to students ask their own questions.
- contribute to the development of students' views.
- challenge false views of students' and enable them to develop their views.
- sustain the attention of students and increase the motivation.
- develop students' language and literature.

Concept cartoons present many opportunities to learners to enhance their learning and motivation at many levels. The literature also reveals that concept cartoons are used in teaching science and technology and in different conditions for the purpose of assessing the comprehension levels of scientific subjects of prospective teachers (Chin & Teou, 2008). In addition, it is stated that concept cartoons contribute to the development of students' problem solving, and critical thinking skills. Further, they are considered helpful to students' concentration because they render science more interesting (Keogh & Naylor, 1999). Such innovative teaching approach is absent in Ghanaian JHS science classroom. This has constantly been reflected by their poor BECE grades. In 2011, 13% of the pupils who sat for the BECE obtained grades 1 to 3 in science with the other 87% obtaining grades 4 to 6. In 2015, 45% obtained grades 1 to 3 with the remaining 55% obtaining grades 4 to 6. In 2016, 20% of the pupils obtained grades 1 to 3 with 80% obtaining grades 4 to 6. In 2017, 35% of the pupils obtained grades 1 to 3 while 65% obtained grades 4 to 6. These statistics suggest that pupils' performances have not been the very best over the period under review. Some stakeholders (school heads, parents, and teachers) were of the view that an urgent intervention was needed to arrest the declining performance of the pupils in science. However, to the knowledge of the researcher, no discernible efforts have been made apart from verbal instructions to teachers to work harder than before.

A search through available literature showed that some researchers (Nartey, 2017; Asmah, 2016; Adu-Gyamfi, 2016) variously designed different interventions to improve learners' achievement in the sciences in Ghana. However, none of these studies considered the use of concept cartoons. Available empirical evidence on the effectiveness of concept cartoons makes it a viable alternative as an intervention instrument.

3. Methodology

Case study design was used to investigate the effect of concept cartoons on Junior High School pupils' performance on selected integrated science concepts with action research as the most appropriate research approach because it is an interactive method of collecting information that is used to explore topics of teaching, curriculum development and student behavior in the classroom (McCallister & Levitas, 2020). Burns (2000) acknowledges action research as an influential tool for school and classroom investigation. The purposes of action research in education he asserts is a means of remedying problems in a specific situation or somewhat improving a given set of circumstances and also aims at changing things.

3.1 Sample

The study was carried out with a public JHS with a population of 198 pupils. The study sample was an intact class of 37 JHS form two pupils and their science teacher.

3.2 Research Instrument

The instruments used in this study were pre-and post-intervention tests, interview and observation schedules. Observations of a typical classroom situation were made before the intervention. These were used by the researcher to have an idea of teaching strategies used by science teacher during instruction.

The pre-and post-intervention tests were constructed by the researcher. The concepts of the following topics were tested: diffusion, osmosis, heredity, mixtures and electrical circuits. The topics were to be treated that term. Five questions were set on diffusion. Questions 1 to 4 required the pupils to define and explain diffusion and its applications in daily life. Question 5 required the students to construct concept maps on diffusion. The pupils were expected to draw lines with arrowheads between bubbles to show which words were related to each other. The test on osmosis consisted of five questions which required the pupils to define, describe the process and state whether statements on osmosis were true or false. Ten test items were set on mixtures of which 6 were multiple choice items and four items required the pupils to explain. The test on heredity consisted of five items which required the pupils to provide one-word answer or explain the concepts. The test on electrical circuit consisted of ten multiple choice items.

Interview was used to obtain data from teachers and pupils on the performance of the pupils in science, the teacher's teaching strategy and their views on the use of concept cartoons in the teaching and learning of integrated science. Semi-structured interview was employed in the study allowing both the interviewer and the respondents the flexibility to go into details when needed (Keller & Conradin, 2018) and where necessary the sequence and wording of the questions changed for better clarification depending on the needs of the interviewee (Johnson & Christensen, 2008).

3.3 Validity and reliability of instruments

Experts in science education examined the interview and test items to examine the suitability of the wording of each of the items. Suggestions received from them were used to refine and sharpen the content making them more relevant and valid for the purpose of the study.

The reliability of the tests was determined using the test-retest method. The tests were administered to a different group of JHS pupils who had the same characteristic as the sample. The reliability indexes were determined using SPSS version 20. A reliability index of 0.66, 0.69, 0.66, and 0.80 respectively was determined for tests.

3.4 Intervention

Figure 1: Lesson and cartoon ideas on diffusion

Figure 2: Lesson on heredity

Figure 3: Cartoon ideas on heredity

Figure 4: Lesson on osmosis

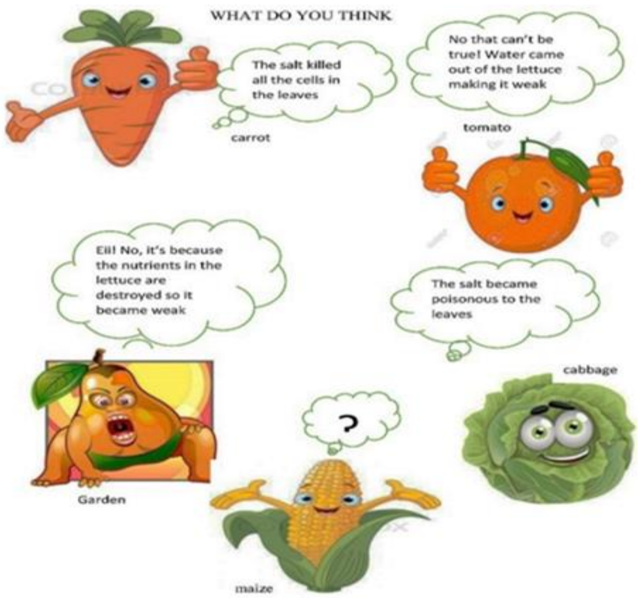


Figure 5: Cartoon ideas on osmosis

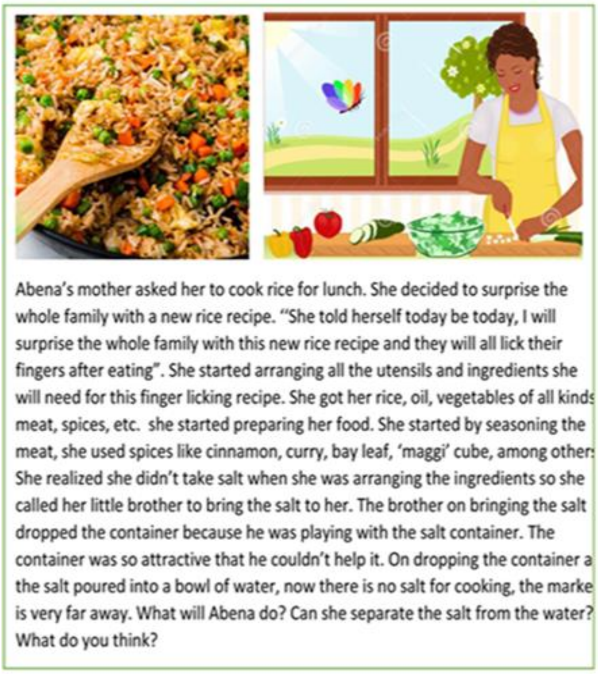


Figure 6: Lesson on mixtures

Figure 7: Cartoon ideas on mixtures

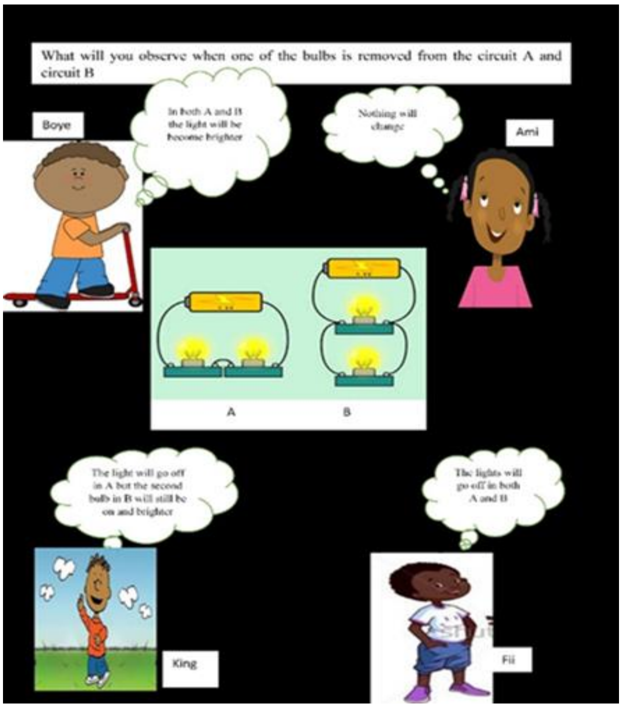
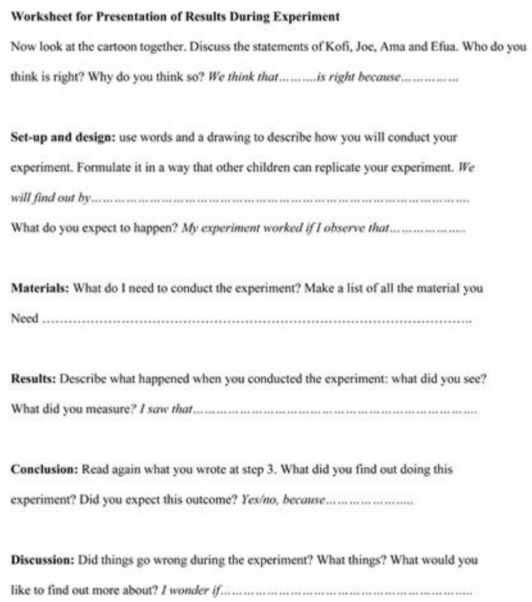


Figure 8: Lesson and cartoon ideas on circuits



Worksheet for Presentation of Results During Experiment

Now look at the cartoon together. Discuss the statements of Kofi, Joe, Ama and Efua. Who do you think is right? Why do you think so? *We think that………is right because……………*

Set-up and design: use words and a drawing to describe how you will conduct your experiment. Formulate it in a way that other children can replicate your experiment. *We will find out by……………………………………………………………………………*

What do you expect to happen? *My experiment worked if I observe that………………*

Materials: What do I need to conduct the experiment? Make a list of all the material you Need ……………………………………………………………………………………

Results: Describe what happened when you conducted the experiment: what did you see? What did you measure? *I saw that…………………………………………………………………*

Conclusion: Read again what you wrote at step 3. What did you find out doing this experiment? Did you expect this outcome? *Yes/no, because……………………*

Discussion: Did things go wrong during the experiment? What things? What would you like to find out more about? *I wonder if……………………………………………………*

Figure 9: Worksheet for presentation of results

3.5 Data Collection Procedure

Data was obtained through Pre and post intervention tests observation and interview with teachers and pupils. Observations of a typical classroom situation were made before the intervention. Science lessons were observed by the researcher to have an idea of teaching strategies used by science teacher in the classrooms. The science teacher and his pupils were interviewed. The interview was based on the performance of the pupils in science, the teacher's teaching strategy and views on the use of concept cartoons in the teaching and learning of integrated science. Pupils took the pre-test a day before the intervention.

Pupils were then taught using concept cartoons (Appendix A). Before giving out the concept cartoons, pupils were put into groups of 5 to 6 pupils. Five different concept cartoons representing the five selected concepts (mixtures, heredity, osmosis, diffusion and electrical circuit) together with worksheets (Kruit, Berg & Wu, 2012) were prepared by the researcher and used to teach the concepts in Junior High School form two class. The pupils had no experience with concept cartoons. Each concept cartoon was accompanied with either a short story or a question for investigation by the pupils. The researcher used the concept cartoons to teach the selected concepts. Each group of students was walked through the five stages of the 5E Model namely, engagement stage, exploration stage, explanation stage, elaboration stage and evaluation stage to investigate and to prove or disprove an idea presented by the cartoon or the question. Pupils then wrote their findings on the worksheet provided.

During the engagement stage pupils predicted the responses to the cartoons they deemed right after group discussion of the phenomenon represented on the concept cartoon. Their predictions and reasons were written on the worksheet. Each group then designed their own experiment and executed it to confirm or disconfirm their predictions during the exploration stage.

The researcher guided the students through the explanation stage. The researcher engagement involved providing labels, that is, scientific terms or concepts for students' findings and content information, correcting students' mistakes and providing information to fill in missing parts in the pupils' outcomes. The researcher confirmed or challenged pupils' explanation of their findings. The pupils were given opportunities to compare their newly structured ideas with those presented by the researcher. Also, the learners began to put the abstract experiences into communicable form.

The elaboration phase encouraged pupils to expand on the concepts they had learned, made connections with other related concepts, and applied their understandings to the world around them. The researcher asked probing questions to extend the pupils' acquired knowledge on the selected concepts. The evaluation phase offered pupils the opportunity to assess their understanding and abilities, and also for the researcher to monitor how pupils' understandings had progressed.

3.6 Data Analysis

Data from the observation checklist and the interviews were checked for similarities or differences and subsequently organized into categories and themes. Evidence gathered from these sources over a period of time provided a broader and deeper understanding of pupils' knowledge and learning (Sagor, 1992). The t-test inferential statistic was used to establish any significant difference between the respondents' mean scores of the pre- and post- test data. Paired- sample t-test was used for the analysis because there was one group and the data was collected from the group on two different occasions, before and after the intervention. The effect sizes were calculated to measure the strength of the relationship between the two tests scores.

4. Results and Discussion

4.1 What are the causes of poor performance of JHS pupils in science?

This item sought to find out the cause of poor performance of JHS pupils in science. Data was gathered using observation and interview. Data collected was based on the performance of the pupils in science, the teacher's teaching strategy and their views on the use of concept cartoons in the teaching and learning of integrated science.

The teaching and learning of science was abstract. The pupils were not offered the opportunity to create their own knowledge. Also, due to the abstract nature of the lessons, the pupils were unable to participate and those who attempted to answer questions posed by the teacher did not get them right.

Time allocated to teach science on the timetable was inadequate for both practical and theory so the teacher resorted to lecture approach to deliver his lessons with pupils. Science concepts need more time to be explained, pupils are therefore, overwhelmed by loads of information in a short period of time. This results in unsuccessful learning among pupils. The pupils complained that they needed more time to understand all the information. A pupil had this to say:

'we don't have enough time to learn science, our teacher rushes us through the syllabus. In some cases, he doesn't even complete a topic he starts'.

The teacher also indicated that science is taught, learnt and assessed theoretically and that experiments are done theoretically. He further noted that pupils do not interact with the scientific material so they do not have the opportunity to discover concepts by themselves. Additionally, he said learners struggle with the section that tests experiment in the exams because they had never seen the material and had never done that experiment. The teacher had this to say:

'This school as well as our neighboring schools lack teaching and learning materials for science experiments. The pupils don't even know what a science laboratory looks like yet we expect them to learn science and understand'.

Lack of resources such as individual textbooks for the learners, and science laboratories are challenges faced by teachers and pupils. This poses a threat to successful science learning because it limits the work of the teacher. It also means that the subject is theoretically taught with no practical investigations. According to Opara and Etukudo (2014) adequate and appropriate use of instructional material ensures effective teaching and learning of science. If instructional materials are inadequate, students are made to read textbooks while the teachers explain the concepts to them instead of the students carrying out activities as suggested by the science syllabus (Azure, 2015). All these factors he said demotivates them as science teachers and the pupils. Motivation he indicated is very important towards the academic achievements of the learners. The intervention in this study was made to address these problems

4.2 What is the effect of concept cartoons on the JHS pupils' performance on selected integrated science concepts?

The study also sought to find out if concept cartoons had any effect on the cognitive achievement of pupils. The descriptive statistics for the five tests are presented in Table 1.

Table 1: *Descriptive Statistics of Pupils' pre- and post-Test Scores*

Test	Mean	N	SD
Diffusion			
Pretest	8.5	37	3.0
Posttest	12.4	37	3.7
Osmosis			
Pretest	9.6	37	2.4
Posttest	12.5	37	2.3
Heredity			
Pretest	9.3	37	2.6
Posttest	10.9	37	2.8
Mixtures			
Pretest	9.8	37	1.9
Posttest	12.9	37	2.0
Electrical circuits			
Pretest	9.4	37	1.8
Posttest	11.9	37	1.6

The mean scores for the pre-test on the topics were within the range of 8.5 to 9.8 while for the post-test means scores within the range of 10.9 to 12.9. The pupils seemed to have performed better after the intervention in all the posttests. The Mean scores of pupils' scores on the post-tests were higher than the corresponding pre-test scores.

The mean differences are between 1.6 and 3.9 (Table 2). The performance of the pupils on the topics improved after the use of concepts cartoons to teach the topics. This suggests that the use of the concept cartoons might have improved the pupils' performance on the topics.

The pupils' mean scores for the corresponding pre and post test scores were subjected to t-test analysis to establish any significant difference between the pre-.and post-test mean scores. The results are presented in Table 2.

Table 2: t-Test Analysis on Pupils' corresponding Pre-and Posttest Mean Scores

	Mean Difference	SD	T	df	P
Diffusion					
Pretest-posttest	3.9	2.8	8.405	36	.000
Osmosis					
Pretest-posttest	2.8	1.8	9.377	36	.000
Heredity					
Posttest-pretest	1.6	1.9	4.851	36	.000
Mixtures					
Posttest-pretest	3.2	1.8	10.578	36	.000
Electrical circuit					
Posttest-pretest	2.5	1.3	11.853	36	.000

Results from the Table 2 indicate that there was a significant difference between the pretest and post-test mean scores in all the five tests conducted after the intervention. For the test on diffusion there was a significant difference between the mean scores (t (36)=8.41, p=.000) with the effect size of 1.15 which is interpreted to be a large difference, the pupils performed better. The test on osmosis also saw a significant difference between the mean scores (t (36)=9.38, p=.000) with an effect size of 1.54 indicating a large difference, the pupils performed better in the posttest after the intervention. There was a significant difference between the mean scores of heredity (t(36)=4.85, p=.000) with an effect size of 0.78 indicates a large effect size. This means there was better performance after the intervention. For the test on mixtures there was a significant difference between the mean scores (t(36)=10.58, p=.000) with an effect size of 1.78 interpreted as a large difference. There was also a significant difference between the mean scores of electrical circuits (t(36)=11.85, p=.000) with an effect size of 1.9 which is a large difference. These results suggest that the intervention improved the pupils' performance in the posttest.

Results from the statistical analysis in the data from the pre-and post-test indicated a significant difference between the mean scores of the pretest and posttest. This implies that the use of concept cartoon had a positive effect on the cognitive achievement of pupils. The pupils performed better in the posttest after the intervention. The results prove that active learning and constructivist approach enhances the cognitive achievement of pupils. Kaufman (2012) discovered that teachers, who use more learner-centred practices such as the constructivist strategies involving students, produce greater motivation and academic improvement than those who use more of teacher- centred approaches like the transmissive or lecture methods.

It was discovered in this study that concept cartoons affected learners' academic achievement in positive ways. Pupils did their possible best to construct their own knowledge and to make meaning of their everyday experiences. This was supported by their responses during the interview sessions. They reported that they had better understanding of the concepts when the concept cartoons were used to teach the topics. This assertion is amplified by the following excerpts:

"Madam, I think cartoons learning is interesting. I watch cartoons on television but didn't know it can be used to learn science. I understood the lesson very well because the cartoon gave me some things to think about".

"Madam, I think learning like this is very nice. It made me understand very well what we learnt. I now understand why they say science is all about the things around us".

These views of pupils correlated their performance in the posttest since they performed better in the posttest than in the pretest.

The teacher also noted that the concept cartoons adapted to the 5E learning model can enhance pupils reasoning processes and also can improve pupils understanding because of the pupils' involvement in the stages of the 5E learning model. Feasey (2007), Hatzitaskos and Karacapilidis (2010), Keogh and Naylor (1999), and Long and Marson (2003) are of the view that concept cartoons have a positive effect on pupils' levels of knowledge in relation to daily life. Similarly, in their research conducted with primary school fourth grade pupils, Özyılmaz-Akamca, and Hamurcu (2009) found that computer assisted concept cartoons had positive effects on learning achievement.

The use of concept cartoons in inquiry learning of integrated science gave the pupils the opportunity to discuss the different opinions presented in the cartoons, made predictions and had the chance to reason through the lesson. The researcher acted as a facilitator and helped in this process so that reasoning could be done effectively. In this way, the pupils learnt various concepts more effectively by constructing them on their own. This confirms the assertion by Heitzmann and Ellmann cited in Kolokouri and Plakitsi (2016) that cartoons are a significant tool for designing educational material as they offer pupils the opportunity to develop high cognitive operations.

5. Conclusion

The ultimate goal of education is to equip pupils with the knowledge and skills essential for thinking critically, solving complex problems, and thriving in the 21st century society. The findings of the study give credence to the ability to achieve these skills through the use of concept cartoons in science lessons. Concept cartoons subsumed by the 5E instructional model improved the pupils' cognitive achievement as seen in their performance in the post-tests (See Table 1). It can be concluded that the use of concept cartoons is one of the effective ways to teach the selected topics used in this study. Further more confident, for higher achieving learners the use of concept cartoons can be an important tool in getting them to think more deeply about scientific concepts.

5.1 Recommendations

The JHS integrated science syllabus is planned to increase the level of scientific literacy of pupils and equip them with the relevant basic scientific knowledge and skills needed for their own survival. It is therefore essential for pupils to be trained in the investigative process of solving problems. This requires pupils to physically explore and discover knowledge within their environment and in order to be scientifically literate and to live meaningful lives. The following recommendations are offered:

1. The biggest challenge before a science teacher is how to teach science effectively for conceptual change. This study has proven that concept cartoons can be used in the science classroom to achieve this. So, it is recommended that JHS integrated science teachers could adopt concept cartoons to teach topics their pupils consider to be difficult.
2. The concept cartoons approach used in the study motivated and increased pupils' participation and achievement in the teaching of the selected concepts of integrated science so JHS science teachers are encouraged to use concept cartoons to increase the pupils' motivation to learn science.
3. Integrated science is a discipline that involves seeking rational solutions to problems and concept cartoons lessons can be presented as a problem to be solved. Therefore, teachers should embrace the use of concept cartoons and present science concepts as problems to be solved for pupils to develop problem-solving skills.

6. REFERNCES

Adu-Gyamfi, K. (2016). *Improving chemistry pupils' conception of redox reaction.* Unpublished master's thesis. University of Cape coast

Asmah, J. K. (2016). *Developing a model for teaching practical skill in titration in public schools in the KEEA municipality of the central region.* Unpublished master's thesis. University of Education, Winneba

Azure, J. A. (2015). Senior High School students' view on the teaching and learning of integrated science in Ghana. *Journal of Science Education and Research*, 1(2), 49-61

Balım, A.G., Inel, D. & Evrekli, E. (2008). The effects the using of concept cartoons in science education on pupils' academic achievements and enquiry learning skill perceptions. *Elementary Education Online. 7*(1), 188-202.

Baure, R. R. (2015). *The state and quality of science teaching and learning in the Sunyani municipality*. Unpublished master's thesis. University of Education, Winneba

Burns, R. B. (2000). *Introduction to research methods*. 4th ed, SAGE Publications, London.

Bybee, R.W., Taylor, J.A., Gardner A., Scotter, P.V., Powell, J.C., Westbrook, A. & Landes, N. (2006). The BSCS 5e instructional model: Origins and effectiveness. *Office of Science Education National Institutes of Health.* 1-80.

Chin, C. & Teou, L. (2008). Using concept cartoons in formative assessment: scaffolding pupils' argumentation, *International Journal of Science Education*. 1-26

Eminah, J. K. (2007). The alignment of JHS science curriculum intentions and classroom practice in Ghana. *Journal of Development Alternatives and Area Studies*. *26* (3): 73-101

Feasey, R. (2007). *Primary science for teaching assistant*. New York: Routledge.

Hatzitaskos, M., & Karacapilidis, N. (2010). Fostering learning through the use of argumentative serious games. In A. Villafiorita, R. Saint-Paul, & A. zorer (Eds), *E-infrastructure and e-services on developing countries* (pp.1-10). Germany, Berlin: Springer. http://dx.doi.org/10.1007/978-3-642-12701-4_1

İngeç, Ş. K. (2008). Use of concept cartoons as an assessment tool in physics education. *US-China Education Review*. *5* (11): 47-54.

İngeç, Ş. K., Yıldız, İ., & Ünlü, P. (2006). *Identification of misconception about uniform circular motion by the use of concept cartoons, VII*. National Science and Mathematics Education Conference, September 6-8, Ankara, Turkey.

Johnson, B., & Christensen, L. (2008). *Educational research: Quantitative, qualitative and mixed approaches.* Sage Publication

Kabapinar, F. (2005). Effectiveness of teaching via concept cartoons from the point of view of constructivist approach. *Educational Sciences: Theory and Practice. 5*(1):135-146 http://cimm.ucr.ac.cr/ojs/index.php/eudoxus/article/view/136/137

Keller, S. & Conradin, K. (2018). *Semi-structured interview.* http://www.sswm.info/planning-and-programming/decision-making/gathering-ideas/semi-structured-interviews

Keogh, B., Naylor, S. (1999). Concept cartoons, teaching and learning in science: An evaluation. *International Journal of Science Education*, *21*(4): 431-446. http://dx.doi.org/10.1080/09500699290642

Keogh, B., Naylor, S. (1999). Concept cartoons, teaching and learning in science: An evaluation. *International Journal of Science Education*, *21*(4): 431-446. http://dx.doi.org/10.1080/09500699290642

Keogh, B., Naylor, S., & Downing, B. (2003). *Children's interactions in the classroom: Argumentation in primary science.* Paper presented at 4th European science education research association conference. Noordwijkerhout, Netherlands.Klahr, D., Zimmerman, C., &

Jirout, J. (2011). Educational intervention to advance children's scientific thinking. *Science. 333* (6045): 971-975. http://doi.org/10.1126/science.1204528

Kruit, P., Berg, E., & Wu, F. (2012). Getting children to design experiments through concept cartoons. Paper presented at the Fibonacci conference on Inquiry Based Science & Mathematics Education: Bridging the gap between education research and practice, Leicester, UK. http://kennisbank.hva.nl/document/480167

Kolokouri, E., & Plakitsi, K. (2016). A chat approach of light and colors in science teaching for the early grades. *World Journal of Education. 6* (4).

Long, S. & Marson, K. (2003). Concept cartoons. *Hands on Science*. *19*(3): 22-23

Martinez, Y. M. (2004). *Does the K-W-L reading strategy enhance student understanding in an honors high school science classroom*? Unpublished Master Thesis, California State University: Fullerten.

McCallister, J. & Levitas, J (2020). *Action research in education: Methods and examples.* Action Research in Education: Methods & Examples - Video & Lesson Transcript | Study.com

Nartey, C. K. (2017). *Exploring the effectiveness of 3E, 5E learning cycles and the conventional approach in a biology lesson.* Unpublished master's thesis. University of Cape Coast.

Naylor, S., Keogh, B., de Boo, M., & Feasey, R. (2001). Formative assessment using concept cartoons: initial teacher training in the UK. In R. Duit (Ed.) *Research in science education: Past, present and future*, pp.137-142. Dordrecht: Kluwer.

Opara, P. N.& Etukudo, D. U. (2014). Factors affecting teaching and learning of basic science and technology in primary schools. *Journal of Educational policy and Entrepreneurial Studies*, 1(1), 46-58

Özyılmaz Akamca, G. & Hamurcu, H. (2009). Analojiler, kavram karikatürleri vetahmin-gözlem- açıklama teknikleriyle desteklenmiş fen ve teknoloji eğitimi. *E- Journal f New World Sciences Academy, 4* (4).

Pelaez, N. J., Hoover, M. A., & Treagust, D. F. (2004). *Concept cartoons reveal differences when HS pupils study blood circulation using live organism versus video.* Paper presented in American educational research association annual meeting, San Diego.

Parku, A. (2012). *A survey of some aspects of the teaching and learning of integrated science in JHS in the Central region*. Unpublished master's thesis. University of Education, Winneba.

Sagor, R. (1992). *How to conduct collaborative action research*. Association for supervision and curriculum development, the University of Michigan.

WAEC (2015). Chief Examiners Report.

7. Appendix A

Figure 1: lesson and cartoon ideas on diffusion

Concept Cartoon Lesson on Heredity

It's a good thing to get married especially to the person who makes you happy. Okpoti papa and Okpoti maame are one such happy couple who have been married for decades. They are never tired of each other and their home is the warmest place one can ever be. They have a lovely family which is the envy of all their neighbors and distant friends. They are blessed with six children, three boys and three girls. Their children are so intelligent that they always top their various classes. Out of the six children Abinana, the first born is fair in complexion with the rest five dark in complexion. She is so different from the other siblings that people who know the family are of the view that he is not the true son of this couple. One day Abinana fell sick. She was taken from one health center to another but to no avail. her parents spent huge sums of money just to make her well, then one day a friend advised them to take her to Dabodabo clinic. They took a bold step and sent her there. God being so good she started responding to treatment but she required blood transfusion. The parents and siblings' blood group did not match her blood group. The five siblings have the same blood group with Abinana's blood group different. The father became angry and with impatience started accusing the wife of bringing another man's child to him. He however indicated that there was no one in his family with the features of the girl in question, the wife also said same. IS OKPOTI PAPA RIGHT? WHAT DO YOU THINK?

Figure 2: Lesson on heredity

Figure 3: Cartoon ideas on heredity

Concept Cartoon Lesson on Osmosis

My sister kept lettuce in salt water when she was preparing vegetable salad. She left the rest of the lettuce in ordinary water. After some minutes, she observed that the leaves in the salt water were not as they were when she bought them, they have become weak and they ones in ordinary water looked very fresh and firm. What happened to the leaves in salt water?

Lettuce in salt water

Lettuce in ordinary water

Figure 4: Lesson on osmosis

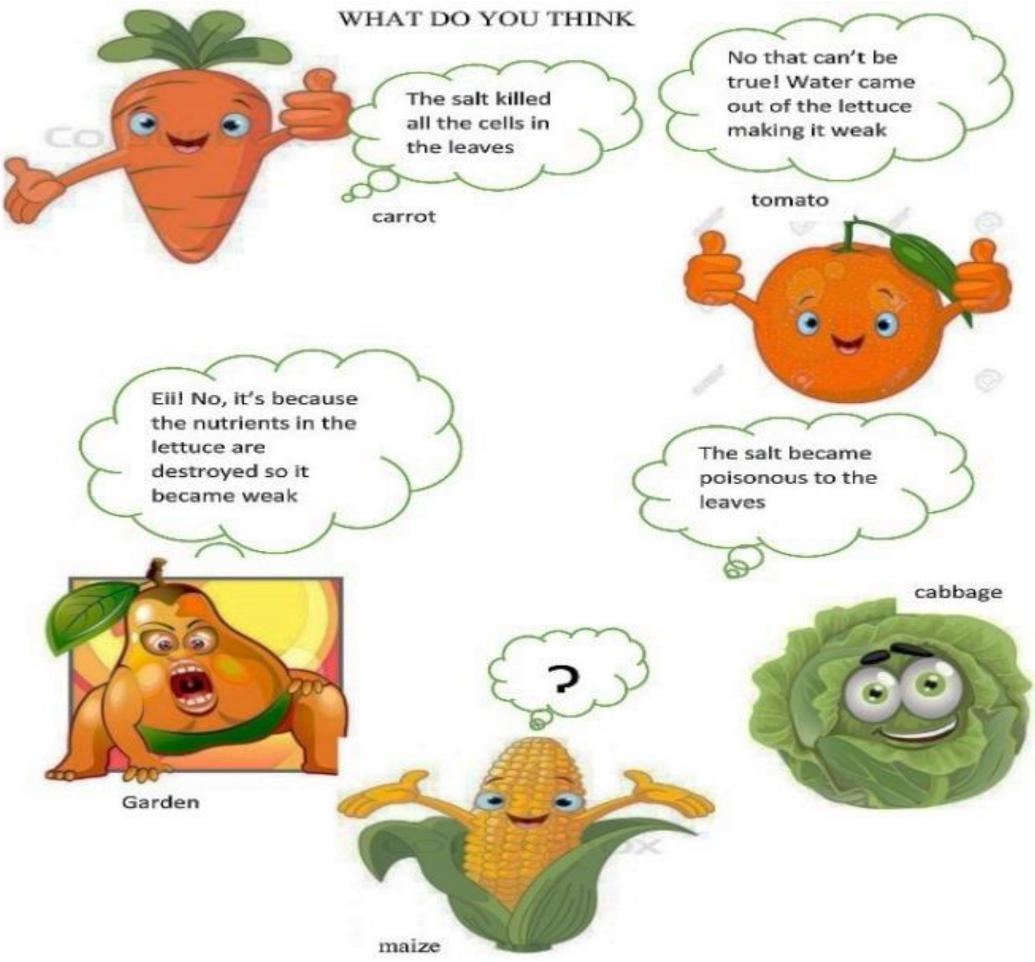


Figure 5: Cartoon ideas on osmosis

Abena's mother asked her to cook rice for lunch. She decided to surprise the whole family with a new rice recipe. "She told herself today be today, I will surprise the whole family with this new rice recipe and they will all lick their fingers after eating". She started arranging all the utensils and ingredients she will need for this finger licking recipe. She got her rice, oil, vegetables of all kinds meat, spices, etc. she started preparing her food. She started by seasoning the meat, she used spices like cinnamon, curry, bay leaf, 'maggi' cube, among others She realized she didn't take salt when she was arranging the ingredients so she called her little brother to bring the salt to her. The brother on bringing the salt dropped the container because he was playing with the salt container. The container was so attractive that he couldn't help it. On dropping the container a the salt poured into a bowl of water, now there is no salt for cooking, the marke is very far away. What will Abena do? Can she separate the salt from the water? What do you think?

Figure 6: Lesson on mixtures

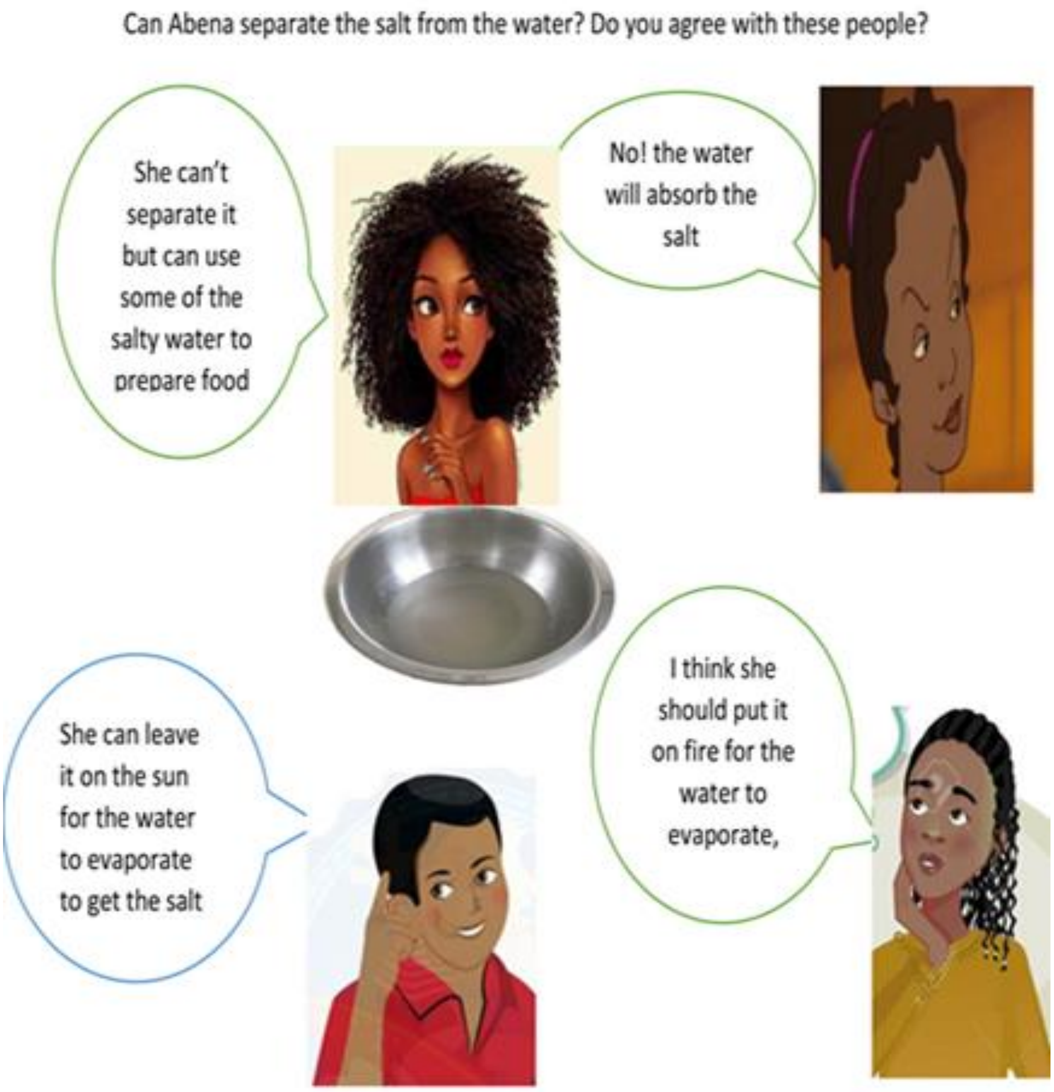


Figure 7: Cartoon ideas on mixtures

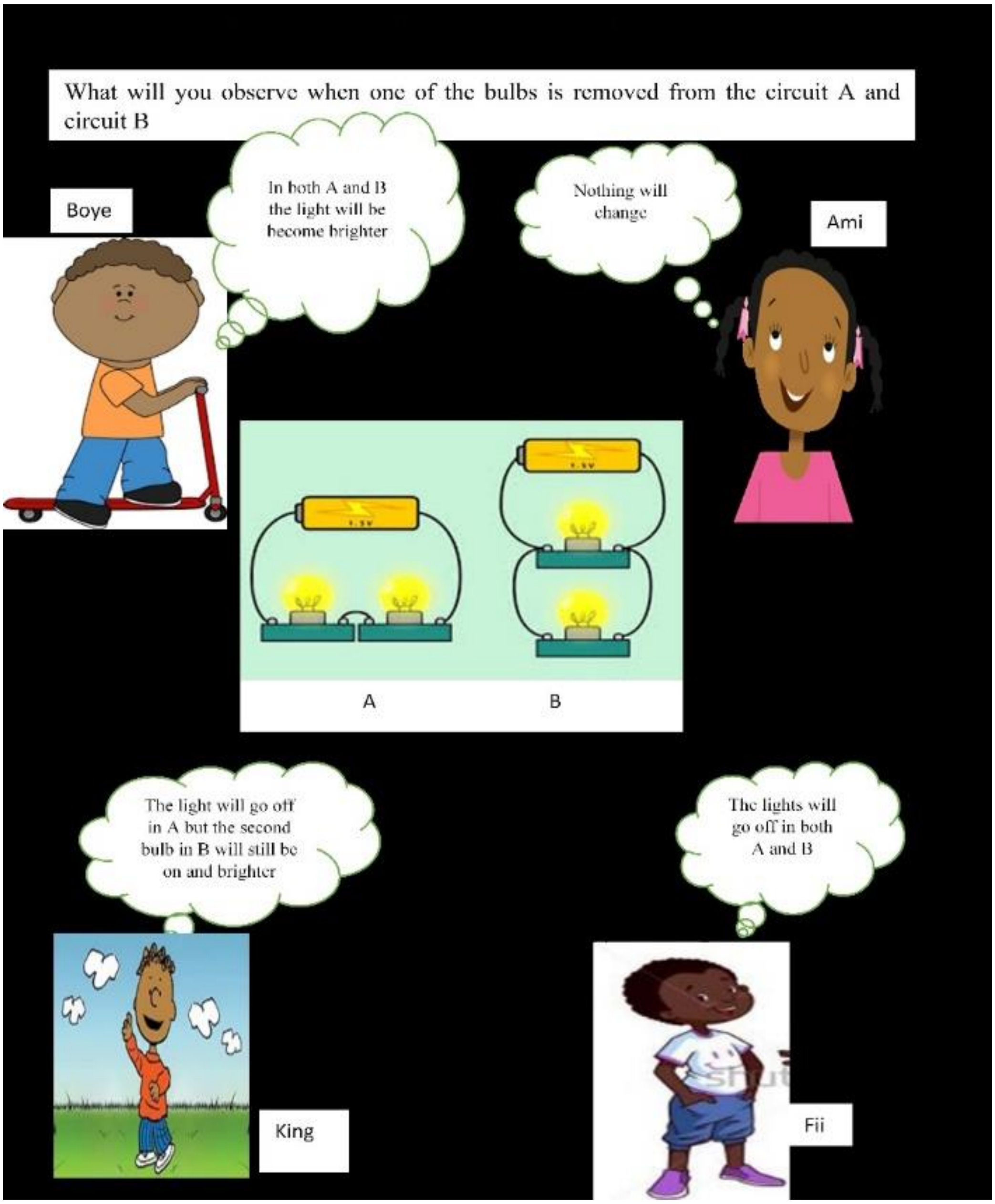


Figure 8: Lesson and cartoon ideas on electrical circuit

Worksheet for Presentation of Results During Experiment

Now look at the cartoon together. Discuss the statements of Kofi, Joe, Ama and Efua. Who do you think is right? Why do you think so? *We think that……….is right because……………*

Set-up and design: use words and a drawing to describe how you will conduct your experiment. Formulate it in a way that other children can replicate your experiment. *We will find out by…………………………………………………………………………….*

What do you expect to happen? *My experiment worked if I observe that………………..*

Materials: What do I need to conduct the experiment? Make a list of all the material you Need ……………………………………………………………………………………..

Results: Describe what happened when you conducted the experiment: what did you see? What did you measure*? I saw that…………………………………………………………….*

Conclusion: Read again what you wrote at step 3. What did you find out doing this experiment? Did you expect this outcome? *Yes/no, because…………………..*

Discussion: Did things go wrong during the experiment? What things? What would you like to find out more about? *I wonder if………………………………………………………..*

Figure 9: Worksheet for presentation