THE IMPACT OF USING COMPUTER SIMULATIONS ON THE PERFORMANCE OF GRADE 11 LEARNERS IN PREPARATION OF SOLUBLE SALTS

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Abstract: The research effort examined two study areas. Firstly, the impact of using computer simulations on the performance of grade eleven leaners in preparation of soluble salts. Secondly, the study focused on assessing learner attitudes towards the teaching methods. The computer simulated method which was used as a treatment showed a statistically significant rise in the conceptual understanding and performance of the preparation of soluble salts by the experimental group in comparison with the control group at alpha level of 0 .05.
Attitudes towards computer simulation learning preparation of soluble salts were obtained through a 15 item five -point Likert scale questionnaire and generally, learners showed positive attitudes towards the learning method. It was concluded that computer simulations improved learner performance on chemistry concepts (preparation of soluble salts) and learners showed positive attitudes towards the teaching methods as suggested by the measure of central tendency.

Key terms— Performance, Computer simulations, conceptual understanding, Perception, Effectiveness, soluble salts

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1 INTRODUCTION

This introductory chapter examines challenges on conceptual understanding of the preparations of soluble salts and proposes the use of Computer Simulation as a solution to conceptual understanding on the preparation of soluble salts as a remedy-Computer use in teaching and learning has overtaken the education sector from (Kent & Mcnergney, 1999). At secondary school level teachers have incorporated the use of technology in order to equip learners with life skills such as communicating well, evaluation as well as creativity for the future is seen to be dependent wholly on technology (Aoude, 2015). Technology is expected to equip students with other skills also such as organizational skills, integration of information and contextualizing of what they learn in class to be beyond the classroom setup (Kozielska & Kedzierski, 2009).

In 2018, Sántha-Malomsoki stated that the integration of computers in science and mathematics can influence how one thinks around a particular concept. According to Greenfield 1984, when a mind is repeatedly exposed to computer games and other digital media, it may enhance a number of skills such as inductive learning which appreciates skills like competence, visual and spatial domains, development of mental maps, inductive learning which includes creation of hypotheses and thinking in a dimensional manner at a very tender age. This is very important in problem solving situations that learners will be faced with in their day to day lives.

The impact of integrating technology in education has led to the discovery of new educational philosophies such as" Digital Wisdom" by Prensky (2009) who believes that digital technology not only makes people smarter, but also wiser. As a result, Prensky defines "Digital wisdom" as the wisdom that originates from the use of digital technology in order to access cognitive capabilities beyond our innate ability, as well as the wisdom to use technology prudently in order to improve our capabilities (Shiels, 2012).

In this context, the learning environment can be defined as all of the student's internal or external surroundings that serve to support learning. Educational environment must be able to commensurate with the needs and abilities of the student so that he can interact with other students and the environment alike that increases the quality of collaborative learning (Sanjaya and Wijaya 2007). Moreover, in order to extend and develop a long- term strategy to enable learners in the education process to improve their practical skills and achievement, this aforementioned design should take place in the learning system. For example, what is needed is the provision of environmental criteria and conditions that enable the creation of effective learning groups to carry out a certain mission. This might include writing a report, fulfilling a project, accomplishing assignments or creating a white paper, with integrating technology being required to achieve their tasks in the learning environment criteria in a single session or over several weeks (Lu 2007).

2. RESEARCH DESIGN AND METHODOLOGY

According to Philliber et al. (1980), research design is a "blueprint" for research, making clear at least four problems such as, which questions to study, which data are relevant, what

data to collect and how to analyze the results. The research targeted grade 11 learners because the problematic topic is placed under grade 11 work in the 5124 Chemistry syllabus. The study employed a pre-test post-test control group quasi experimental research design. Pre-test was administered to the experimental group and control group to determine whether students had any pre-existing knowledge on the topic of salts as well as homogeneity of the two groups. An intervention to the experimental group in form of simulations on soluble salts and the control group through discussion method was administered, thereafter, a post-test was given to both groups. Random assignment was used to assign experimental and control group through a coin (heads and tails).

3.1.1. Pre-intervention

This stage involved a practical test that was administered to both groups, it helped in finding out about what salts are and how one can make soluble salts. The reason for this stage was to gauge the homogeneity of the two groups, the questions required them to use the prior knowledge of symbols, valences, chemical formulae and salts. It also helped the researcher to understand the prior information the learners have on soluble.

3.1.2. Intervention

This is the stage that involved teaching of soluble salts with the aid computer simulations method to the experimental group which was obtained from. http://www.olabs.edu.in/?pg=topMenu&id=41 and conventional method (discussion and lecture) to the control group. During the intervention the experimental group used computer simulations as an aid to understanding concepts on soluble salts. This design was modified according to the research questions and objectives. The learning model adopted was because it consists of engaging learners in important stages allowing them to be actively involved in the exploration of scientific concepts, the stages below highlight how the cycle was be used.

Steps in the Using Computer Simulations adopted for the study

The facilitator highlighted to the learners that they needed to conduct the steps below for them to get familiar with the website.

Steps to conduct in this practical using a computer simulation are as follows:

1. Go to http://www.olabs.edu.in/
2. Then click on Home on your two bar formatting
3. Click where it is written chemistry
4. Click where it is written class 11
5. From class 11 click on a topic Quantitative Estimation
6. Then click on simulator
7. On the simulator choose the simulator type
8. Choose the titrant(acid type) with a click
9. Increase or decrease the speed of drops with a click
10. Go down to choose the type of an indicator
11. Then you can click on a start button
12. Click on show volume of titrant
13. When the end point is reached click stop button
14. Write a balanced chemical equation for the reaction between an acid of your choice and a base given to you.
    _____
    _____
15. Calculate the number of moles of titrate (base).
    _____
    _____
    _____
16. Calculate the number of moles of a titrant (an acid).
    _____

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_____

17. Calculate the molarity of titrant using a dilution formula, M1V1=M2V2.

_____
_____
_____

18. Calculate the molar mass of the titrant.

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19. Write the summary of the practical.

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20. Conclusion.

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All the above steps were given to the experimental group during contact teaching of soluble salts, and the teacher in this case was a facilitator. The experimental group was exposed to computer simulations whereas the control group was taught using conventional method (lecture).

3.1.3 Post intervention

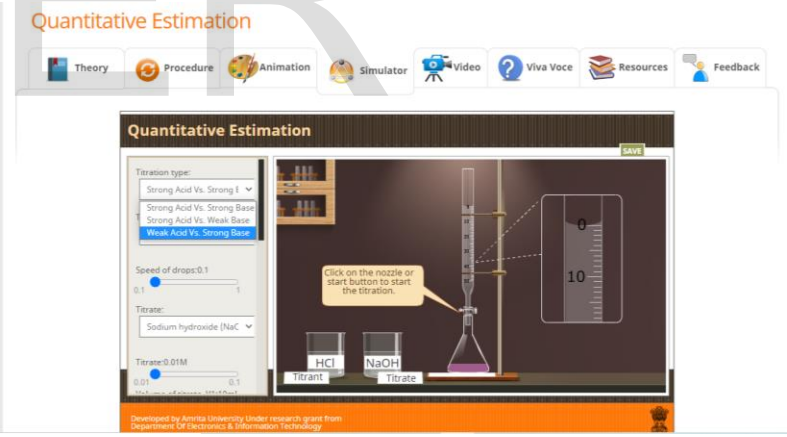
This stage of the research design was conducted in one stage. The stage involved administering a practical test to both groups on soluble salts in aqueous solutions. A questionnaire to determine learner attitudes towards the teaching method was administered to the learners at the end in that order.

3.2 Study Population

The grade eleven's of a named Secondary School in Kitwe district were used in this research. The school comprised of four classes, a total of one hundred and thirty six (136) grade eleven learners and the researcher only used two classes of which one was the experimental group and the other class was used as control this was because at the time of data collection, classes were alternating and management only gave the researcher to work on specific times.

3.3 RESEARCH INSTRUMENTS

The researcher used two research instruments to capture data namely, a performance test to collect scores and a questionnaire to collect attitudes of learners. At the beginning of the study, all participants sat for a pretest before instruction took place. During the instruction phase, the experimental group was taught using computer simulations, and the control group was instructed using discussion and lecture methods. A lesson plan was prepared by the researcher, and it included some activities that were common for the experimental and the control groups, and other activities that were different between the 2 groups. Figure 2 below shows some of the simulations that were extracted from computer simulations used by the experimental group. The questionnaire was in form of a Likert scale that has been adapted (Muşlu Kaygisiz et al., 2011). Validity of the performance test was done with the help of an expert who is my supervisor and also the questionnaire was piloted with just one class before administering it to a larger sample.



4.0 DATA PRESENTATION AND FINDINGS

Data analysis and findings are presented in this chapter. This research set out to investigate the impact of collaborative learning using computer simulations on learner's conceptual understanding of soluble salts. The study focused on grade 11 at Mukuba secondary school and data pertaining to the performance tests towards the teaching method was collected and analyzed. The findings of the investigation are presented in form graphs and tables.

4.1 Data Analysis

There are three things that need to be considered in data collected, these include, getting a feel of the data, testing the goodness of the data and answering the research questions this is according to Sekeram (2003). Sekeram further stated that when the goodness of the data is established, credibility of the data is assured.

The scores of the pre-test and post-test were calculated out of 100 and are given in the appendices. Statistical Package for Social Sciences version 22 (SPSS) was used to analyze the different data sets. Means of the pre-test and post- test and their standard deviations are given in Table 4.1. Grade 11P was taught computer simulations of soluble salts and 11M was taught using conventional method.

Pre-test and Post-test distribution of scores are shown in figures 3, 4, 5 and 6 *below.*

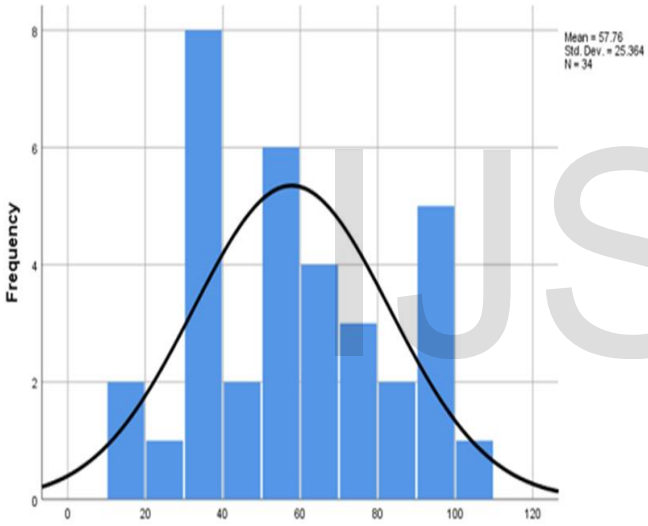


Figure 3 Pre-test Distribution of 11P Experimental Group

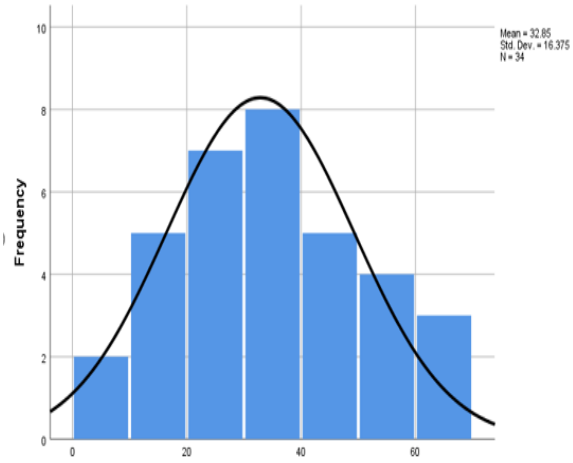


Figure 4 Pre-test distribution of 11M Control Group

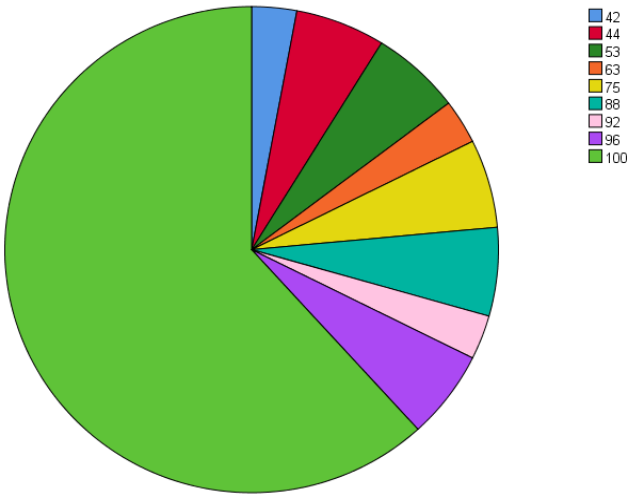


Figure 5 Distribution of Post-test for 11P Experimental Group

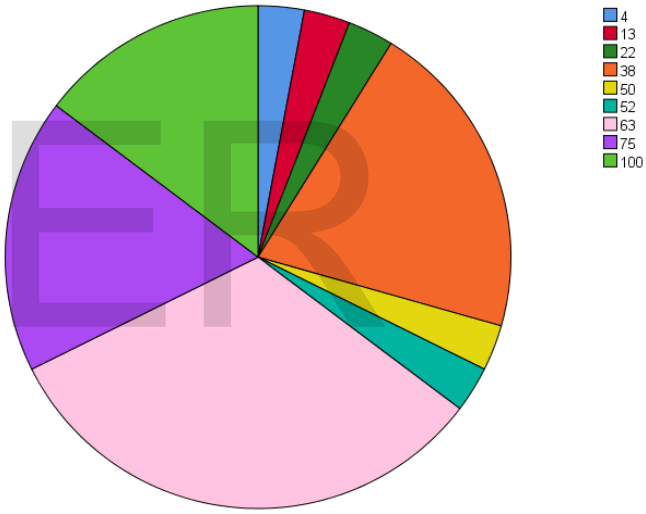


Figure 6 Distribution of Post-test for 11 M Control Group

Table 4. 1. General Mean and Standard deviation of the Pre-test and Post-test for the two classes

	Grade 11P (34)		Grade 11M (34)	
	Mean	SD	*Mean*	SD
Pre-test	**48**	**20**	**36**	**17**
Post-test	**89**	**19**	**61**	**24**

SD- Standard deviation

In order to see if the groups were homogeneous at the beginning, an independent sample t-test (a test that compares means of two different samples) was run. The results shown in table 4.2 below show that there is no significant difference between the two groups at the beginning of the study. This is

because the p-value is greater than the set alpha value (0.05).

Table 4.2. Comparison of the Pre-test scores for 11P and 11M

Scores				T-test	
	N	***Mean***	***SD***	**df**	**t** **p**
11P	34	**48**	**20**	**66**	**0.29** **0.07**
11M	34	**36**	**17**		

N- Number of participants, SD- Standard deviation, df- Degree of freedom, t- Calculated t value, P- Probability level

The two classes were taught soluble salts which is a topic under acids and bases in grade 11. Scores of the pre -test and post of both groups were compared within the groups using a paired sample t test
to see the effect of the treatment. The results show that both groups improved after instruction but the group taught using computer simulation (11P Table 4.3) improved more than the conventional group (11M Table 4.4). A significant difference between the pre-test score and the post score within each group was observed as $p < 0.05$ in both cases.

Table 4.3 Paired Sample t-test for 11P (Experimental Group)

Scores				**Test**	
	N	***Mean***	***SD***	**df** **t**	**p**
Pre-test	**34**	**48**	**20**	**32** **-9.4**	**0.00**
Post-test	**34**	**89**	**19**		

N- Number of participants, SD- Standard deviation, df- Degree of freedom, t- Calculated t value, P- Probability level.

Table 4.4 The Paired Sample t-test for Control group 11M.

Scores				T-test	
	N	***Mean***	***SD***	**df** **t**	**P**
Pre-test	**34**	**36**	**17**	**32** **-5.01**	**0.000**
Post-test	34	61	24		

N- Number of participants, SD- Standard deviation, df- Degree of freedom, t- Calculated t value, P Probability level

In order to examine the difference between computer simulation and conventional teaching in this case lecture method, post-test scores of the two groups were subjected to an independent sample t test. The post-test scores of the experimental which was the computer simulation group (11_P) showed a greater improvement than that of the control group (11_M). The independent t test showed that there was a significant difference between the two teaching methods as shown in Table 4.5

Table 4.5 Comparison of Post-test scores for Computer Simulations (CS) 11P and Control group 11M

Scores				**T-test**	
	N	***Mean***	***SD***	**df** **t**	**P**
CS	**34**	**89**	**19**	**66** **3.65**	**0.02**
Conventional	34	61	24		

N- Number of participants, SD- Standard deviation, df- Degree of freedom, t- Calculated t value, P- Probability level

It can be seen that there is a significant difference between the two-teaching method and the collaborative learning integrating computer simulations group outperforming the conventional group. This has been seen in terms of the mean score which is higher in the experimental group than the control group.

4.1.2. Calculating Effect size

Effect size which gives a magnitude of difference between the two groups was also calculated using the post-test of the experimental group and the lecture group. This was done using Eta squared method. Eta squared was found to be 0.01.

Therefore, this means that the difference between the computer simulation group and the conventional group was small. Effect size between the two groups was 0.01. According to Cohen (1988), Eta squared values are interpreted as follows; $0.01 \leq$ eta squared <0.06 small effect, $0.06 \leq$ eta squared < 0.08 moderate effect and $0.08 \leq$ eta squared < 0.16= large effect.

Learner responses from the questionnaire were summarized in as shown in Table 4.8 which highlighted the total numbers for each questionnaire response and percentages respectively.

Table 4.8 Responses to the questionnaire

The participants in both groups (n=34)					
Frequency Times (n=34) and percentages					
Question items	1	2	3	4	5
1. Computer simulations are very important In acquiring chemistry concepts	(22) 65%	(8) 24%	(2) 5%	(1) 3%	(1) 3%
2. I would like to use the computer simulations In order to grasp concepts on soluble salts	(18) 53%	(11) 32%	(5) 15 %	-----	-----
3. Computer supported learning is important for me	(8) 24%	(9) 26%	(5) 15 %	(8) 24%	4 11%
4. It can improve creativity in learning of soluble salts computer simulation supported learning is used.	(19) (56%)	(15) (44%)	-----	------	------
5. I will search for ways of using the computer effectively in learning on soluble salt preparation	(20) 59%	(9) 26%	(5) 15 %	------	------
6. Teachers should encourage use of computer simulations Beyond the classroom setup.	(30) 88%	(2) 6%	(1) 3%	……	(1) 3%
7. Teachers should encourage use of computers with other chemistry topics.	(24) 70%	(7) 21%	(2) 6%	(1) 3%	------
8. I learnt more with computer supported learning than the other methods and techniques	(32) 94%	(1) 3%	-----	(1) 3%	------
9. Contribution of education with computer supporting can help me to study extra hard beyond what I learn in class.	(29) 85%	(5) 15%	-----	------	------
10. I think computer simulations are an effective teaching Tool	(26) 76%	(4) 12%	(3) 9%	-----	------
11. I don't use the computer for supporting my lesson except when required	(30) 88%	(4) 12%	-----	------	------
12. Computer supported teaching is a waste of time.	(1) 3%	(2) 6%	-----	(19) 56%	(12) 35%
13. I prefer lecture instead of computer supported learning			(5) 15 %	(25) 73%	(4) 12%
14. Computer simulations can help me to connect concepts easily on soluble salt preparation	(12) 35%	(10) 29%	(12) 35 %		
15. Integrating computer simulations in learning concepts on soluble salt can help me to look forwards to learning chemistry	27 79%	3 9%		4 12%	

1=strongly agree, 2=agree, 3 = neither agree nor disagree, 4=disagree, 5=strongly disagree.

This questionnaire was a Likert scale designed, items were designed so as to expose learner attitudes towards learning soluble salts using computer simulations, for example, the interest towards this mode of instruction was investigated by using the Likert scale item number seven that asked students' opinion if they would like to experience learning of this kind with other chemistry topics. The result of this investigation was showed that most learners strongly agreed giving the highest percentage of approximately 70% and 20% merely greed to the statement. Another Likert scale item asked for the learners' opinion if this kind of learning using computer supported learning helped them more than other teaching methods and techniques used on them, the results of this investigation was that many of the learners strongly agreed giving a

percentage of 94%, about 3% merely agreed to the statement and only 3% disagreed to the aspect of computer simulations helping them to grasp concepts easily compared to other teaching techniques.

After exposure to computer simulations, learners' developed courage to contribute their views on issues relating to how soluble salts can be prepared in the laboratory. Learners were also capable of contributing their views on which anion produced a particular precipitate when added to a particular substance.56% strongly agreed to the fact that computer simulation supported learning improved creativity in their learning of soluble salts, 44% merely agreed to the fact.

The Likert scale was also formulated to investigate if students thought integrating computer simulations is time consuming during learning of soluble salts. Over 50% of learners disagreed to this statement which showed that they actually thought integrating computer simulations was an important aspect to getting involved in the teaching and learning process.

The central tendency is a characteristic that shows representativeness of numbers that characterizes middleness of a data set was calculated (Jackson 2009). Median (middle number) and Mode (frequent number) for each statement were used to measure central tendency independently as shown in table 4.8

Table 4.8 Median and Mode for each questionnaire item

Statement	N	Median	Mode
1	34	1	2
2	34	2	1
3	34	1	2
4	34	1	2
5	34	2	1
6	34	1	2
7	34	1	2
8	34	2	2
9	34	1	1
10	34	2	1
11	34	1	1
12	34	4	4
13	34	4	4
14	34	1	1
15	34	1	1

The overall median calculated was 1 which translates to agreeing with most statements except for 12 and 13. The overall mode was also calculated 1 showing a confirmatory test that was conducted on the numbers. This translates to results showing most learners having positive attitude towards the teaching method.

5.0 DISCUSSION OF FINDINGS

5.1 Learner's Performance

Results obtained in the pre-test showed that there was no statistically significant difference between the experimental and the control group in relation to the knowledge soluble salts. This meant that at the beginning of the research the two groups were uniform because of p-value which was found to be greater than the set significance level ($p > \alpha$) as seen in Table 4.2 was 0.07.

Experimental mean after treatment increased in pre-test 48 to post-test 89. This increase was statistically significant. Similarly, there was a statistically significant increase in the mean score for the control (lecture) group from a pre-test mean of 36 to post-test one mean of 61. In both cases for the experimental and the control $p<\alpha$ showing that learning had taken place in both cases.

The gain score on the performance of students in relation to preparing soluble salts from the pre-test to the post-test after applying computer simulations showed no significant difference. In agreement with studies earlier conducted in physics education (Chisha & Shumba, 2019; MWAMBA et al., 2019; Nkemakolam et al., 2018). The group that used computer simulation in learning soluble salts understood concepts on soluble salts easier than the group that was taught using lecturer method but, in both cases, it can be seen that learning occurred due to the increase in the group means. This significant difference could have been caused by the experience given to the experimental group students where they were able to explore concepts on soluble salts through the manipulation of laboratory apparatus in a virtual manner (Dale, 1954).

Students showed enjoyment as they worked through the worksheets. The steps involved

- Engagement of the learners to actively participate in class through exercises online
- Explorations through manipulation of laboratory equipment virtually and seeing the actual precipitates formed so as to come up with conclusions

- Elaborating different identified salts prepared by the learners through an exercise to consolidate their conceptual understanding of types of salts formed

- Evaluation by the teacher through giving the learners' feedback and feedforward on their explanations and elaborations on the identification of ions concepts.

Similarly computer simulations had been shown as an important tool in a science classroom as shown by studies conducted around the globe, this is because learners are actively involved during the learning process (Adams et al., 2008; Finkelstein et al., 2005). These studies concluded that computers are an effective way of helping learners become creative during a lesson and that learners are encouraged to be independent thinkers which is an important tool in meaningful learning. The independent sample t-test between the experimental group and the lecturer method group showed a significant difference between the two teaching methods as shown in Table 4.5 which had a p-value of 0.02.

This research also agrees with Chisha and Shumba, 2019 and MWAMBA *et al.*, 2019 found in 2019 who emphasized that computer simulations is one of those teaching methods that employ exploration, experimentation, and manipulation virtually. This can be very helpful in the absence of an actual laboratory and learners find it easy to grasp concepts in a science classroom.

The implications of these findings are that if computers are well integrated in the teaching and learning of soluble salts and other chemistry concepts to similar sets of learners taking chemistry 5124, learners will highly benefit from such a teaching strategy. The benefits of such a teaching strategy will come in form of improving learner performance in the understanding soluble salts and other scientific concepts within a science classroom. This will in turn improve the performance of learners in chemistry as well as science as a whole.

It is important to note that the success this teaching technique at national level would largely depend on how many schools implement it and how well this teaching method is implemented not leaving learners to entirely use computers without guidance from the teachers because this may lead to learners diverting the original use of the computers within a classroom setup.

5.2 Attitudes of Learners towards the teaching technique

In order to find out learner attitudes on the use of integrating computer simulations as an instruction in teaching a 15 item Likert scale attitude questionnaire was given to participants in the experimental groups at the end of the treatment. The questionnaire assessed attitudes of learners towards this method and attitudes towards the topic preparation of soluble salts as shown in Table 4.5 The learner perception of the teaching approach was modelled around computer simulations and how different salts whether soluble or insoluble behave and how this teaching approach will improve their performance and understanding of this particular concept in chemistry. Question 8 was an important question which showed that 32 learners strongly agreed that they learnt more with computer supported learning than the other methods and techniques bringing the percentage to 94% and 1 merely agreed to the fact, giving a percentage of 3% where as another 3% representing 1 student disagreed that this teaching technique was not helpful.

From Table 4.8 the overall median and mode were calculated from the responses of the participants. The general results showed that learners agreed to learning preparation of soluble salts through computer simulation integration. It can be seen that when computers are part of learning in a science classroom, learners tend to show positive attitudes towards the learning of chemistry.

The implication of the questionnaire results is that if this kind of learning is used, learners will generally have a different perception towards the subject and they can easily relate chemistry concepts to each other. This will be able to change teaching environment easily because of the experience given to them. This is a teaching method that can help to improve the performance of learners in Zambia and the world at large.

According to the present study, the general picture of learner attitudes towards this teaching strategy is positive. This purely means that the integrated computer simulations in the teaching and learning enhances understanding of chemistry concepts and in turn improve learner performance. If this teaching strategy is implemented in similar sets of learners, it can be welcomed. This is an important aspect in any kind of learning because a positive attitude towards learning a particular concept, gives learners positive energy and a drive to learn beyond a classroom setup.

The findings of this study revealed that integrating simulations is an effective way of teaching the preparation of salts concepts and the positive attitudes toward the teaching strategy translates to all kinds of benefits that come with it such as a better understanding of content knowledge, improved creativity, problem-solving skills and improved student communication skills because of the confidence learners will have in being able to manipulate virtual instruments.

6.0. CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the conclusions and recommendations on the findings obtained from the current study.

6.1. Conclusions

The study established that integrating computer simulations in teaching and learning of soluble salts had a positive impact on learners understanding of the concepts easily. From the study, it can also be concluded that giving learners chance to manipulate instruments virtually using simulations in a science classroom engages them to be part of what is happening in the lesson. After preparing salts using computer simulations, learners developed creativity skills, problem solving skills, critical thinking skills, communication skills and they were able to hypothesize, evaluate and draw conclusions based on their experience. Learners were actively involved in manipulating laboratory equipment virtually and were able to draw conclusions from whatever they were doing and seeing. Hands on and minds on activities which helped them to participate in scientific investigations to verify science concepts on their own.

It can also be concluded that if learners are given a practical experience, learning will be very effective because learners will not only see science concepts from an abstract point of view without marrying it to any practical work.

Furthermore, the findings revealed that learners experienced this kind of teaching technique with positive attitudes as they enjoyed the lesson progression and they would want to learn other chemistry topics using this mode of instruction.

6.2. Recommendations

1. Chemistry topics should be taught by giving learners practical experience so as to enable learners to actively participate and this will enhance the understanding of these scientific concepts whether hands on or virtual.

2. Learners should be guided to in using computers because on their own with minimal help from the teacher. This will enable learners to actively engage their minds and hands leading to creativity and extension of concepts beyond the classroom setup.

3. Learners should be encouraged to develop personal experiences in the learning process as this may help them retain a great percentage of knowledge learnt hence a better performance, this may be achieved through manipulations of instruments.

4. Curriculum developers should emphasize on the use of experiential learning during the teaching especially on topics like preparations of soluble salts as this will enable learners to learn meaningfully according to Brunner 1961.

5. Further research can be conducted by using this mode of instruction with other chemistry topics or others subjects, by increasing the number of schools.

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