

Enhancing students' development of Collaborative skills among Secondary School Chemistry Students using Computer-Aided Strategy

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Abstract

The aim of this study was determine students' development of collaborative skills in learning Chemistry when taught using Computer-Aided Strategy (CAS) in secondary schools. The study adopted Quasi Experimental design based on Solomon Four- Group, Non-equivalent Control Group Design. The participants were 174 Form Two secondary school Chemistry students in Tharaka Nithi County in Kenya. Four schools were purposively sampled and randomly assigned as either Experimental groups or Control groups. The students of the Experimental groups were taught through Computer Aided Strategy while the Control groups were taught through Conventional Instructional methods. Data was collected using Classroom Observation Schedule (COS) and was used to obtain information relating to the collaborative skills of students during teaching and learning of Chemistry. The quantitative data was analyzed using both descriptive and inferential statistics with the aid of SPSS version 20 program. Mean and standard deviation were used to describe the data while One-way Analysis of Variance (ANOVA) was used to test the hypothesis. The study revealed that the students who were taught Chemistry with computer aided strategy obtained higher collaborative skills scores than the students who were taught with conventional instructional methods. Thus, Chemistry teachers, should adopt Computer Aided Strategy in their teaching to help in enhancing students' development of collaborative skills, and by extension improve performance in Chemistry.

Keywords: Computer Aided Strategy, conventional instructional methods, students' collaborative skills

1. Introduction

Development of Collaborative skills is increasingly becoming an important component of learning in the 21st Century classrooms. Collaborative skills helps two or more people to work together and function well to achieve the set goals and complete tasks (Intel Corporation, 2007). According to Intel Corporation (2008), collaborative skills refers to students demonstrating teamwork and leadership; adapting to varied roles and responsibilities; working productively with others; exercising empathy; and respecting diverse views. Collaborative skills are part of 21st century competences necessary for raising the quality of education geared towards the realization of

Kenya's vision 2030 (Republic of Kenya, 2012). More significantly, collaborative skills enables the people to participate effectively in knowledge-based economy (Republic of Kenya, 2012). For this reason, the Ministry of Education in the sessional paper No. 14 of 2012, affirms commitment to competency-based teaching and learning that promotes acquisition of collaboration skills and attitudes (Republic of Kenya, 2012).

According to Trilling and Fadel (2009), collaborative skills helps the learners to work effectively and respectfully with diverse teams, exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal, and assume shared responsibility for collaborative work, and value for individual contributions made by each team member. This implies that collaborative skills are essential elements for effective learning, hence the need to enhance the development these skills among students in teaching and learning of any subject. To the contrary, the instructional methods that the Kenyan teachers use in the classrooms do not seem to engage the learners in developing their collaborative skills.

For instance, a situational analysis conducted by CEMASTEIA (2009), observed that majority of the science and mathematics teachers offered inadequate opportunities for learners to interact in groups in their lessons. According to this situational analysis report, majority of the lessons observed were "whole class" instruction which accounted for 62.5% of the lessons observed while "small group" instruction accounted for 25% and instruction in "pairs" accounted for 4.2% of the lessons observed. The report revealed minimal student-student interaction, hence low acquisition of collaborative skills by learners during learning of Chemistry. This minimal development of collaborative skills by students in learning Chemistry is a matter of great concern.

Use of computer-supported learning in which learners are allowed to work together in small groups over a computer on a shared assignment or an exercise, affords collaboration learning environment (Dukuzumuremyi, 2014). With computer-aided strategy, a programmed computer poses questions preferable ones demanding analysis, evaluation or synthesis and gives students (working over a computer) appropriate time to think through an appropriate response. Students then pair and share their responses. This is followed by student responses being shared within a four-person learning team and finally the responses shared with an entire class during a follow-up discussion. The groups are usually composed of different students in each session. This kind of arrangement that allows all students an opportunity to share their responses with one another, may enhance collaboration and interaction among learners.

1.2 Statement of the problem

While the development of collaborative skills have been recognized as an important component of learning in the 21st Century classrooms, the social dimension of collaborative learning has received less attention by researchers than the cognitive components. Available researches on collaborative learning have mainly focused on improvement of cognitive components, leaving the development of students' collaborative skills lacking in scholarly work. Due to this gap in research literature, the study aimed at determining the students' development of collaborative skills in learning Chemistry when taught using computer-aided strategy.

1.3 Purpose of the study

The purpose of this study was to determine students' development of collaborative skills in learning Chemistry when taught using Computer-Aided share Strategy (CAS) in secondary schools of

Tharaka-Nithi County in Kenya. This entailed comparing the development of collaborative skills in the CAS strategy and Conventional Instructional Methods (CIM).

1.3.1 Objective

The objective of the study was to determine students' development of collaborative skills in learning Chemistry when taught using Computer- Aided Strategy and Conventional Instructional Methods.

1.3.2 Research questions

To what extent are students developing collaborative skills in learning chemistry when taught using Computer Aided Strategy and Conventional Instructional Methods?

1.3.3 Hypothesis

There is no significant difference in the collaborative skills scores of students when taught using computer aided strategy and conventional instructional methods.

2. Literature review

Research literature on use of computers in learning has revealed that use of computers contribute to increased interaction and reception of information, and change the communication models and give way to new scenarios which favor collaborative learning (Noor-ul-Amin, 2013). According to Johnson and Johnson (1999), social interaction is a prerequisite for collaboration and collaborative learning. If there is no social interaction then there is also no real collaboration. Kearsley (1995), echoes that social interaction in computer-supported collaborative learning must be organized, otherwise it is unlikely to occur or be meaningful. Coble and Koballa (1996) indicated that social interaction is necessary if learners are to be exposed to new ideas about Science teaching and learning and to coordinate their own ideas with those of others. Fall and Webb (1997) recommend, providing explicit instruction to developing collaborative skills, such as instruction in effective communication, how to seek help, and how to provide help to others. Similarly, Webb (1991 and 1995) recommends training students in general collaboration and teamwork skills, including coordination, communication, conflict resolution, decision making, problem solving, and negotiation. Such training assist learners on how to give explanations, how to directly and explicitly ask for help, and how to respond appropriately to others.

Teachers should also provide ample opportunities for students to practice collaborative skills, using tasks that are similar to those used during group-based assessments. To institute measures which support the development of collaborative skills through group roles, Brush (1998) suggests, consistent prompting and reminding the group members of their roles throughout the learning activity. Research on computer-supported collaborative learning has attempted to explain theoretical benefits of collaborative learning in face-to-face settings through computer-mediated interactions that are limited to asynchronous, text-based interactions. For example Dukuzumuremyi (2014), found collaborative learning strategies that are computer- supported to be resourceful ways of developing collaborative skills in primary school learners.

3. Research Methodology

The study adopted quasi-experimental design based on Solomon Four-Group, Non-equivalent Control Group design. Quasi-experimental design involves no randomization of the subjects to the sample groups but rather involves random assignment of intact classes to sample groups. This

design was chosen because it is very prevalent and useful in Education. It provides reasonable control over most of the variables affecting internal and external validity (Cook & Campbell, 1979).

This design is represented diagrammatically in Figure 2.

Groups	Pretest	Treatment	Posttest
A	O ₁	X	O ₂
.....			
B	O ₁		O ₂
.....			
C		X	O ₂
.....			
D			O ₂

Figure 2: Solomon-four group design, Non-equivalent control group

Figure 2 illustrates the Solomon four-group, Non-equivalent control group design. Four comparably groups were used in the order of A, B, C and D respectively. Two groups A and B were initially given pretest (O₁), afterwards, treatment (X) was administered to group A and C. Finally, posttest (O₂) was conducted to all the groups.

3.1 Population and sample size

Accessible population included Form Two Chemistry students in the 15 secondary schools with computer laboratories in Tharaka Nithi County in Kenya. Four schools were purposively sampled from the 15 schools with computer laboratories. The assignment of the groups (class) to either experimental or control conditions was done using simple random sampling. Random sampling gives each and every school from the target population a known and equal probability of selection (Kothari, 2004).

A total of 45 students were involved in experimental group 1(A), 46 in experimental group 2(B), 45 in control group 1(C) and 38 students in control 2(D). This provided a total sample size of 174 Form Two Chemistry students

3.2 Research instruments

Data was collected using Classroom Observation Schedule (COS). The aim of observation instrument was to obtain information relating to the collaborative skills of students during teaching and learning of Chemistry. According to Mugenda and Mugenda (2003), observational research serves to collect objective information. The COS instrument was used before (pre-test) and after (post-test) the administration of the intervention (CAI). The items in COS contained collaborative skills such students ability to; demonstrate teamwork and leadership skills, adapt to varied roles and responsibilities, work productively with others; exercise empathy; and respect others diverse views. The observational instrument used in this study obtained a minimum of occurrence and not a frequency of occurrence of each particular category. For example, if during a 10-minute period of observation a group (class) demonstrated teamwork on several occasions, the teamwork category was coded only once for that ten minute period. In a lesson lasting for 40 minutes, there were four-

10 minutes periods. The skills categories were rated on a scale of one to four points (1-4) where: 1- skill category not observed, 2- skill category rarely observed, 3-skill category occasionally observed and 4- skill category consistently observed.

3.3 Piloting

The classroom observation schedule was piloted with form two Chemistry students in two pilot schools that had similar characteristics as the study sample. The pilot schools were Extra- County schools. During piloting, adjustments were undertaken with the researcher conducting paired observation to assess the inter-rater reliability. The final version of the classroom observation schedule had a percent agreement of 75 %, which met acceptably high scores of inter-rater reliability.

3.4 Data collection procedure

Data was collected in two phases; pre-treatment period and treatment period. During the pre-treatment period, classroom observations were made before the application of treatment (Computer-Aided Strategy). Two such classroom observations were conducted in two groups (Schools). One of the group was the Experimental and the other one was Control group. Information regarding collaborative skills of students were observed using structured observation schedules. This pre-treatment period was designed to last for two weeks with one session (lesson) classroom observation per week. During treatment period, Experimental groups were taught Chemistry using Computer-Aided Strategy (treatment) while the Control groups were taught using Conventional Instructional Methods. The treatment for Experimental groups involved use of Computer-Aided Strategy in teaching the selected Chemistry topics namely structure of an atom, periodic table and chemical families. While using Computer-Aided Strategy in teaching and learning, programmed computer posed questions, preferable ones demanding analysis, evaluation or synthesis and gave students appropriate time to think through an appropriate response. Students then paired and shared their responses.

This was followed by student responses being shared within a four-person learning team and finally the responses shared with an entire class during a follow-up discussion. On the other hand, control groups benefited from the conventional methods of teaching the same content listed. The treatment period lasted for four weeks in which four classroom observations consisting of one session (lesson) per week were conducted to all the four groups. Classroom observation schedules gathered information relating to the collaborative skills of students in learning Chemistry.

3.3 Data Analysis

The data for every collaborative skill category from each of the four classes (groups) were totaled. These figures were combined and tabulated onto a single observation sheet to provide a total figure for each description. These quantitative data obtained from observation schedules were analyzed using both descriptive and inferential statistics with the aid of SPSS version 20 program. Mean and standard deviation were used to describe the data while One-way Analysis of Variance (ANOVA) was used to test the hypothesis.

4. Results and Discussion

The findings were based on the following hypothesis;

There is no significant difference in the collaborative skills scores of students when taught using Computer-Aided Strategy and Conventional Instructional Methods.

4.1 Pre-treatment scores in Collaborative skills of students

Students in both Experimental and Control groups were observed before the application of the treatment (computer aided strategy). The observation schedule contained learners' collaborative skills such as demonstrating team work, taking roles and responsibilities, giving and accepting help, sharing ideas and materials, and taking turns. These skills were rated on a likert scale of 1-4: where 1 means skill category not observed in the four 10-minute periods; 2- skill category rarely observed in the four 10-minute periods, 3- skill category occasionally observed in the four 10-minute periods and 4- skill category consistently observed in all the four 10- minute periods. The data obtained were analyzed using descriptive statistics and t-test and the results indicated in Table 4.5.

Table 4.5: Descriptive and Independent Sample t-test of Pre-treatment scores in Collaborative skills

Variable	Group	N	Mean	Std. deviation	t-value	df	p-value
Collaborative skills	Exp A	2	19.50	0.707	-0.447	2	.698
	Control B	2	20.00	1.414			

The results in Table 4.5 shows that two observations (N=2) were made for each group (Experimental and Control) and average collaborative skills scores were obtained as 19.50 and 19.50 out of 40 respectively. The computed p-value (0.698) was greater than the set alpha value 0.05. Therefore, the collaborative skills mean scores of both Experimental group and Control group was not significantly different, $t(2) = -0.447$, $p > 0.05$.

This implies that the Experimental and Control groups were similar on collaborative skills scores measure before the administration of the treatment, hence homogenous. This made the groups suitable for the study.

4.2 Effect of Computer Aided Strategy (CAS) and Conventional Instructional Methods (CIM) on students' collaborative skills in Chemistry

The study aimed at establishing whether there was significant difference in collaborative skills scores of Chemistry students between those students taught with Computer Aided Strategy and those taught with Conventional Instructional Methods. Four groups were involved in this study. Two groups (Experimental) were taught Chemistry with computers (CAS) while the other two groups (Control) were taught without computers (CIM). Three impromptu classroom observations to each of the four groups were observed on how students interacted and related among themselves during Chemistry lessons. The major aspects observed were: team work and leadership skills, finding and sharing information, discussing and sharing ideas, giving and accepting help, taking turns in the discussion, adapting to varied roles and responsibilities. The observed skills were rated on a four-point likert scale (1-4), where: 1- skill not observed, 2- skill rarely observed, 3-skill occasionally observed and 4- skill consistently observed. The data obtained was analyzed using descriptive statistics and Analysis of Variance (ANOVA). The descriptive results are indicated in Table 4.6.

Table 4.6: Descriptive statistics of post-test scores in Collaborative skills

Name of group	N	Mean	Max. score	SD
Experimental A	3	36.50	40	2.646
Control B	3	18.40	40	3.055
Experimental C	3	35.60	40	2.646
Control D	3	17.10	40	1.000

The results in Table 4.6 shows that three observations (N=3) were made for each group (Experimental and Control) and an average of collaborative skills scores were obtained. The analysis indicate that the collaborative skills mean scores for Experimental group A and C (36.50 and 35.60) were much higher than those for the control group B and D (18.40 and 17.10). This shows that the students of Experimental groups who were taught Chemistry with Computer Aided Strategy had developed more collaborative skills than students of control groups taught using conventional methods. To determine whether the groups were significantly different on collaborative skills mean scores, OneWay ANOVA test was performed and the results are indicated in Table 4.7.

Table 4.7: One-Way ANOVA of Post-test scores in Collaborative skills

Source of variation	Sum of Squares	df	Mean Square	F-ratio	p-value
Between Groups	1011.000	3	337.000	55.397	.000
Within Groups	48.667	8	6.083		
Total	1059.667	11			

The ANOVA analysis in Table 4.7, reveals that the difference between the collaborative skills scores for students in the Experimental and Control groups was statistically significant, $F(3, 8) = 55.397$, $p < 0.05$. From the findings of this study, it is apparent that use of Computer Aided Strategy enhanced students' development of collaborative skills during Chemistry instruction more than use of Conventional Methods. This findings of study concur with the data of Dukuzumuremyi (2014), which suggested that use of computer supported collaborative learning software and applications in which group members shared one laptop to collaboratively achieve a group task, are a resourceful ways of learning social skills. Computer Aided Strategy plays an important role in enhancing students' collaborative skills during Chemistry lessons because it helps students to learn Chemistry concepts in a collaborative manner. In this study, Computer Aided learning in which group members (consisting of two to four members) shared one computer to collaboratively achieve a group task, helped the students develop collaborative skills such team work and leadership skills. This kind of classroom arrangement caused the students who were taught with computer-aided strategy enhance the development of collaborative skills more than the students in conventional group in chemistry lessons.

5. Conclusions and Recommendations

The study revealed that the students who were taught Chemistry with computer aided strategy obtained higher collaborative skills scores than the students who were taught with conventional methods. Therefore, use of computer aided strategy enhances students' development of collaborative skills during Chemistry instructions more than use of conventional teaching methods. Thus, Computer aided strategy is an effective instructional strategy that aids collaborative learning. Further, from the classroom observations, it was evident that the students who were exposed to computer-aided strategy interacted frequently with one another and with the learning materials in their computers. This kind of arrangement enabled students to positively interact amongst themselves. It therefore appears social interactions plays an important role during Computer Aided learning lessons and in turn lead to the development of both cognitive and socio-affective processes, and subsequently improves learning performance and socio-affective performance. This viewpoint of thinking has been supported by constructivists' theory that advocates social learning. It is clear that social interactions are responsible for the enhanced students' collaborative skills, and by extension improved performance in Chemistry.

The findings of this study challenge the conventional instructional methods that dominates Kenyan Chemistry secondary school classroom instructions. Thus, Chemistry teachers should be encouraged to use Computer Aided Strategy (CAS) in their teaching so as to enhance students' development of collaborative skills. The government of Kenya should provide adequate ICT infrastructure and equipment, including computer hardware and computer aided softwares in all schools. Availability of adequate computer aided hardware and softwares in schools will enable the Chemistry teachers to utilize available Computer Aided Strategy in the teaching and learning processes.

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