

Impact of Collaborative Learning on Student Teachers' Comprehension and Attitudes towards Environmental Education Concepts in Chemistry

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Abstract

The study explored the impact of collaborative learning on student teachers' comprehension and attitudes towards environmental education concepts in Chemistry. The study involved 64 student teachers studying environmental chemistry at Mufulira College of Education in Zambia. The action research adopted a pre-test post-test quasi-experimental design. The students were randomly assigned to the two intervention groups. In both groups students had opportunities to learn pollution, waste management and climate change. In the experimental group they used team based learning while in the comparison group students used think-pair-share learning. Overall, learners' attitudes towards chemistry were improved from pre-test to post-test in both the experimental group. Results from the achievement test revealed a statistically significant difference ($t_{(df, 62)} = 2.030, p = .024$ at $\alpha = .05$) between the mean scores of the experimental group (Mean = 69.75; SD = 13.853) and the comparison group (Mean = 60.67; SD = 14.501) after the experimental Phase. Overall, both forms of collaborative learning incorporating environmental education concepts and issues in Chemistry had a positive impact on learners' comprehension and attitudes towards chemistry.

Index Terms Achievement, attitudes, integrating, environmental education concepts and issues, collaborative team based learning, collaborative think pair share learning.

1. Introduction

Nations at the forefront of modern development are those that have invested enormous resources over considerable time in the establishment and nurturing of a stable well supported science and technology education (Akpan, 2008). In addition to promoting STEM education, Zambia adopted outcomes based education approach that encourages a learner-centered and activity-based approach to education (Ref). The approach is to help the citizenry develop problem solving skills, develop desirable scientific attitudes, acquire the knowledge of their environment and increase their understanding of the role of science in everyday life (Ministry of Education, 2013). The new Zambian school curriculum stresses the need for all science teachers and teacher educators to integrate cross-cutting Issues across the curriculum at all levels of the education system.

In the light of these issues, teachers and teacher-educators should be able to understand these issues better so that they are integrated in the curriculum. Environmental education focuses on certain sets of values, knowledge-perspectives and attitudes which can contribute to environmental friendly action and solving of environmental problems. Pennock and Bardwell, 1994) posited that investigating real-world environmental issues motivates learners by making learning relevant, as well as helping students to practice and develop skills such as decision making, critical thinking, and problem solving. Osowiecki (2011) argued that introducing environmental issues in the science curriculum can help students understand the relevance of science topics, such as environmental chemistry, energy and electricity. Furthermore, Ernst and Monroe (2004) and Glynn (2000) submits that through linking of academic topics to the local environmental topics, students are able to make real-world connections, allowing the material to be made more meaningful, tangible and relevant. This can result in higher motivation and increased interest. Edelson (2007) contends

that in a system where environmental sciences were integrated fully into the curriculum, the sense of purpose for learning science becomes internalized.

Contemporary wisdom regarding the teaching and learning of chemistry identifies a need for teaching approaches that will activate the learner (Eilks and Byers, 2009). Such methods should seek to encourage the learner to become cognitively engaged in developing understanding of the topic being taught (Eilks and Byers, 2009). One practice that has received widespread coverage over the past decades is collaborative, small-group learning (Robyn and Adrian, 2003). This is a pedagogical practice that helps students to gain and create both academic and social relationships as well as to accomplish shared goals (Gillies and Boyle, 2010). Through such kind of interaction, students learn to cross-examine issues, share ideas, elucidate differences, and construct new understandings (Webb and Mastergeorge, 2003). The basic elements of collaborative learning are positive interdependence, equal opportunities, and individual accountability. In collaborative learning students assume new roles of collaborators and active participators. As mediator, the teacher helps students fulfill their new roles.

Several researches have demonstrated the positive relationship between collaborative learning and student achievement, effort, persistence, and motivation (Slavin, 1990; Webb and Palinscar, 1996; Barron, 2000; Johnson *et al.*, 2007). Smith, Hinkley, and Volk (1991) found that students in cooperative method scored significantly higher on their exams than students taught using traditional methods in an undergraduate chemistry course. Jones and Brickner (1996) in a basic mechanics course found that students in the cooperative learning groups showed significant improvements in their quiz scores and expressed more positive comments towards the course. Denila (2010) suggests that motivation and attitude affect the will and interests of students to achieve academically adding that: "When an individual is motivated, interest, paying attention, willingness to make an effort, focusing and devoting on the subject, not giving up in difficult circumstances are observed" (p. 1). Given these links of collaborative learning, achievement and attitudes, it is conjectured that integrating environmental education concepts and issues in teaching chemistry will have the effective of raising attitudes leading to increased attention and effort to learn the chemistry concepts under collaborative learning conditions.

2. Purpose Of The Study

The study aimed to teach an environmental chemistry unit drawing from the College Chemistry syllabus for third year diploma student teachers by integrating environmental education concepts and issues in Chemistry. In doing so the study examined the attitudes of the learners and their achievement scores in a test on types of pollution, Climate change and solid waste management. The study was guided by the broad research question:

- What is the impact of collaborative learning on learners' attitudes and achievement towards environmental education concepts and issues in chemistry?
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3. Research Design And Methodology

The study was an action research that adopted a pre-test post-test quasi-experimental design. For the pre-test and post-test the study utilized researcher developed instruments to measure learner attitudes, motivation, and achievement.

3.1 Study participants

The two science education classes in the college were selected for the study. Class A had 32 learners (22 male and 10 female) while class B had also 32 learners (19 male and 13 female). The 64 student teachers were randomly assigned to the two intervention groups (experimental and comparison groups).

3.2 The intervention

The intervention was a teaching and learning approach in which collaborative learning incorporated relevant environmental education issues in the teaching of chemistry in six 2-hour lessons over a period of three weeks. The two groups were taught types of pollution, solid waste management and climate change contents of the Chemistry syllabus. They were taught by the researcher following the time table designed by the researcher.

The collaborative learning instructional strategy integrating environmental education concepts and issues was used to teach the two groups for three weeks. The experimental group used the team based collaborative learning and the comparison group used the think-pair-share method as summarized in Table 1.

Table 1. Pre-test post-test quasi-experimental design intervention.

Group	Pre-test	Intervention	Post-test
Experimental Group (n=32)	Environmental chemistry test Attitude questionnaire	<i>Duration:</i> 6 × 2 hours (3 weeks) <i>Method:</i> Team Based collaborative learning & integration of environmental education issues (air and water pollutions and environmental impacts, climate change and solid waste management). <i>Content:</i> Types of pollution, Climate change and solid waste management	Environmental chemistry test Attitude questionnaire
Comparison Group (n=32)	Environmental chemistry test Attitude questionnaire	<i>Duration:</i> 6 × 2 hours (3 weeks) <i>Method:</i> Think-Pair-Share collaborative learning and integration of environmental education issues (air and water pollution and environmental impacts, climate change and solid waste management). <i>Content:</i> Types of pollution, Climate change and solid waste management	Environmental chemistry test Attitude questionnaire

As shown in Table 1, the instruments used for pre- and post-test were an attitude questionnaire, an interview guide, and environmental chemistry test developed by the researcher. All the instruments were face and content validated by chemistry lecturers in the Department of Science Education at Mufulira College of Education.

4. Results And Findings

Questionnaire data and achievement pre-test post-test scores were analysed for trends using the SPSS version 16. The results are summarized in Table 2.

4.1 Pre-test and post-test attitude scores

The attitude questionnaire was a 20-item Likert-type scale response developed by the researchers to assess students' attitude towards environmental education concepts in Chemistry. Students indicated their respond to a five point system on the scale as follows: 1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree, and 5 = strongly agree. While, typically, scoring involves summing items in order to indicate relative favourableness to the attitude objective, in this study, for more absolute interpretation, an attitude in this study was taken to be a measure on a continuum from strongly negative affect to strongly positive affect. On the scale the interpretation of attitudes is as follows: 1.0-2.4 scale points reflects tendency to "disagree", 2.5-3.4 "undecided", and 3.5-5.0 "agree". The higher number on the scale (mean ≥ 3.5) represented agreement with the item on the scale and a more favourable disposition to that item.

Table 2: Student attitudes in pre-test and post-tests.

Group	Pre-test Mean (SD)	Intervention	Post-test Mean (SD)
Experimental (n= 50)	<i>Attitude</i> 2.54 (1.262)	Team Based collaborative learning	<i>Attitude</i> 3.28 (1.343)
Comparison (n= 51)	<i>Attitude</i> 2.60 (1.316)	Think-Pair-Share collaborative learning	<i>Attitude</i> 3.05 (1.292)

With this in mind, Table 4.1 shows that there were no differences in all the pre-test measures on attitudes and achievement scores for both the experimental and comparison groups. For both groups, student attitudes tended slightly to disagree or were undecided. For example, in the pre-test learners tended to “disagree” or “undecided” to questionnaire items such as “I am one who enjoys learning Environmental concepts and issues in chemistry”, “Reference to environmental issues in the local environment is good for learning some topics in chemistry”, “Collaborative learning is not very helpful to me.”, “I enjoy learning chemistry using collaborative learning.”

Following the intervention, students’ attitudes in the two groups had changed marginally from disagree tendency towards undecided and agree with the experimental group showing a slight gain in expressing favourable disposition towards the teaching approach and learning of environmental chemistry concepts. They tended to agree more with these items expressing enjoyment for learning environmental chemistry, reference to environmental issues in the local environment and expressing willingness to participate in environmental chemistry lessons.

The results in Table 2 suggest collaborative learning approach integrating education concepts and issues in chemistry had a slight positive impact on learners’ attitudes towards environmental concepts and issues in chemistry. The difference in attitude scores between the two groups after the intervention is for practical purposes the same. A two tailed t-test showed that there was no significant difference between the attitude post-test scores of experimental group and comparison group ($t_{(df, 62)} = 2.347, p = .064, \alpha = .05$). It would appear that these data suggest the positive contribution of integrating education concepts and issues in the chemistry lessons and that collaborative learning is an appropriate approach to assure learners reap benefits of interventions.

4.2 Pre-test post-test achievement scores

A one hour researcher designed Environmental Chemistry Achievement Test consisting of fifty (50) multiple-choice items drawn from chemistry syllabus and past papers was administered to the two groups. It explored students' understanding of environmental chemistry concepts on pollution, solid waste management and climate change. The test scores converted to a percentage score. Table 3 also shows the achievement scores for the experimental and comparison groups at pre-test and post-test.

Table 3: Student achievement scores in pre-test and post-tests.

Group	Pre-test Mean (SD)	Intervention	Post-test 1 Mean (SD)
Experimental (n= 50)	<i>Achievement</i> 52.19 (16.306)	Team Based collaborative learning	<i>Achievement</i> 69.78 (14.395)
Comparison (n= 51)	<i>Achievement</i> 51.25 (15.504)	Think-Pair-Share collaborative learning	<i>Achievement</i> 60.66 (14.132)

The results in Table 3 show that there were no differences in the pre-test achievement scores for both the experimental group (52.19%) and comparison group (51.25%) ($t_{(df, 62)} = -.236, p = .814$). Both groups gained in achievement scores from pre- to post-test. The experimental group using Team Based collaborative learning and integration of environmental education issues showed a gain of nearly 17.59 percentage points from pretest (mean=52.19) to post-test (mean=69.78). The comparison group gained 9.41 percentage points.. A two tailed t-test showed a significant difference between the achievement post-test scores of experimental group and comparison group in favor of experimental group ($t_{(df, 62)} = -2.559, p = .013, \alpha = .05$).

It is possible that that this positive impact on achievement could be results of the raised positive attitudes exhibited in the intervention. This is evident in post-intervention interviews with students. Three excerpts of interviews suffice to illustrate:

Excerpt 1:

Yes it's good to reference local environmental issues in teaching and learning Chemistry, this is because it has helped me develop interest in learning chemistry topics involving types of pollution, climate change and solid waste management. It helped me realize the importance of chemistry in the local context. This made me to be more attentive in all the chemistry lessons

(Learner1)

Excerpt 2:

Yes it is good. Practically speaking, when you look at our town Mufulira, it is a place where we have mining industries. Then we have other types of pollution like air pollution found in town. So it is very important to talk about environmental chemistry and refer to the environment and hah other air pollutions that take place in the environment for easier understanding. It is very ease for the students to understand when you practically talk about something that they see or even something that they practice in their day to day life (Learner 2).

Excerpt 3:

Yes actually I did like the collaborative method very much. Okay firstly I will talk about hah collaborative method was very good or an interesting method of learning because we were working as a group or a team and it was very easy for one to ask a friend if one has any query based on the activity that we were given. So collaborative learning was one of the method of learning which was interesting. It was easier for one to understand we were participating with fellow friends (Learner 3).

5. Discussion

This study finds evidence that the two modes of collaboration learning impacted little on attitudes while increasing achievement when learning chemistry. This action research demonstrates that use of collaborative learning and integration of environmental education concepts and issues from students' local community produced modest gains in attitudes. Following the intervention, learners tended to agree more with these items expressing enjoyment for learning environmental chemistry, reference to environmental issues in the local environment and expressing willingness to participate in environmental chemistry lessons. This could have contributed to the satisfactory achievement levels in the environmental chemistry test. The suggested link of attitudes to achievement needs further study. For example, Denila (2010) suggested that when an individual is motivated "interest, paying attention, willingness to make an effort, focusing and devoting on the subject, not giving up in difficult circumstances are observed" (p. 1). In this study, the slightly improved attitudes possibly enabled students to pay more attention and endeavor to understand the chemistry concepts that led to satisfactory achievement scores. Evidently, collaborative learning and integration of environmental education concepts and issues made learning more joyous, a good condition for effective engagement with the subject matter. This was regardless of the size of the group. It appears that the value of the approach used lies in the integration of environmental topics. This must be explored further in future studies.

6.0 Conclusion

The study found that students who were taught using team based collaborative learning and integration of environmental education concepts and issues resulted in greater achievement compared to the think pair format of collaboration. An impact on attitudes was not significant. This necessitates further exploration. For example, how the integration of environmental education concepts and issues in Chemistry of students would have been expected to enhance attitudes which does not appear to happen here. The present results appear to contradict the popular assumption that integrating environmental education issues instruction has the ability to foster attitude to science that can lead to greater levels of achievement (Wisconsin & Millar,1999; Springer, Stanne and Donovan,1999; Linton,2014; Romero,2009; Karabenick and Collins-Eaglin,1996). Could this relation be context dependent?

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