Assessing strategies for enhancing the integration of cultural practices in teaching and learning of chemistry in secondary schools

Abstract: The purpose of the study was to assess strategies for enhancing the integration of cultural practices into the teaching and learning of chemistry in secondary schools. The study adopted a descriptive survey research design and the population of the study comprised 19,920 respondents. Two research questions and two hypotheses guided the study. The instrument used for data collection was “Strategies Enhancing Integrating Cultural Practices Questionnaire (SEICPQ)” developed by the researchers. Mean and standard deviation were used to answer the research questions and t-test statistic was used to test the null hypotheses at 0.05 significance. The result revealed that incorporation of cultural practices into the chemistry curriculum content and adequate training of teachers on the integration of cultural practices in teaching chemistry and among others were identified as strategies that could enhance the integration of cultural practices. Non-incorporation of cultural practices into the chemistry curriculum content among others were identified as factors affecting the integration of cultural practices. The results also revealed that teachers and students do not significantly differ on their responses on strategies enhancing as well as the factors militating against the integration of cultural knowledge and practices into teaching of chemistry. Necessary conclusions were made.

Keywords: cultural heritage; cultural knowledge and practices; integration; secondary school chemistry; teaching and learning.

1 Introduction

Through a carefully thought-out procedure, education is the process of passing on a people’s culture from one generation to the next. Ayeni and Dada (2011) defined education as the process through which individuals acquire knowledge, skills, attitudes, interests, abilities, competence, and cultural norms of a society in order to transmit those norms to the next generation and promote the society’s ongoing development. Due to its effective contributions to a country’s growth, such as Nigeria, education is in great demand there. One of the courses studied at the secondary and higher levels of education is chemistry. The study of the structure, compositions, reactions, and applications of matter are the main topics in the science discipline of chemistry. Since matter makes up everything on earth, chemistry is a very important aspect of daily life. Nwaka, Egbo, and Okechineke (2016) wrote about its significance and said that almost no production process does not involve one part of chemical processes or another. They claim that chemical principles are used in petrochemical plants, oil refineries, and the production of products like soap, dyes, cosmetics, nylon, glass, plastics, insecticides, etc.

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Despite the fact that chemistry is crucial to a country’s economy, students routinely do poorly on the West African Senior School Certificate Examination (WASSCE), according to the chief examiners’ report from the West African Examinations Council (WAEC, 2020). Therefore, via efficient teaching and learning, it is necessary to enhance the level of academic performance of the students in chemistry. There are two processes going on at once: teaching and learning. Before learning can occur, students must have a thorough knowledge of what the teacher is teaching. As a secondary school chemistry instructor for 20 years, I can speak from experience when I say that pupils do not comprehend or understand what they are being taught in chemistry classes. The concepts are simply memorized by the students, who then replicate them in exams.

Because science is only successful to the extent that it can find a niche in the cognitive and socio-cultural environment of students, Cohen in Olotu and Ugwuanyi (2017) observed that it is essential for educators to understand the fundamental and culturally-based worldviews that students bring to the classroom and how these beliefs are supported by student’s culture. They recommended incorporating indigenous techniques that stem from the cultural legacy of the people into science instruction. In their contribution, Konyela and Okigbo (2021) advocated for the incorporation of ethno-chemistry into the subjects, methods, and practices of chemistry education. Odo (2013) continued by pointing out that nations like Japan, India, China, Kenya, Bolivia, Sri Lanka, and Australia have effectively merged western science with their own vast reservoir of knowledge, experiences, and customs to create a path toward distinctive scientific progress. The students observe daily cultural behaviors and knowledge that are rich in chemistry that are present in underdeveloped nations. Students will link the cultural behaviors they engage in at home to their grasp of chemistry if science teachers use them. In fact, the goals of integrating cultural knowledge and practices into teaching and learning chemistry in secondary schools are strongly related to the purpose of constructivist learning theory, which emphasizes prior knowledge. Indigenous people in poor nations like Nigeria have a variety of cultural traditions and knowledge that they practice. These traditions and information are closely tied to several chemical concepts covered in secondary school.

Indra and Bitwell (2016) noted that although producing table salt can be used to teach certain preparation of soluble salts, blacksmithing can be used to teach the extraction of iron in the blast furnace. Okoko (2019) also claimed that unripe plantain peels can be used to extract valuable compounds such trioxonitrate (v) acid (HNO₃) and trioxocarbonate (vi) (K₂CO₃). In particular, filtering, decantation, distillation, precipitation, boiling, and evaporation can all be taught using the extraction process. Olotu and Ugwuanyi (2017) stress the significance of incorporating cultural indigenous traditions, such as the following, into the teaching of science.

(i) It will increase the interest of scientific instruction and learning.
(ii) Students will recognize that science is not inherently abstract and may be learned from their surroundings.
(iii) It will make it easier for local technologies to develop for societal and economic advancement.
(iv) When indigenous techniques are incorporated into western schooling, society will feel a sense of belonging and relevance.
(v) Students can still learn science even if there are difficulties due to a lack of laboratories the community offers a location where practical activities can be learned.

Despite the efforts of chemistry educators to advance different approaches to incorporating cultural knowledge and practices into teaching and learning of chemistry, as well as the significance of such integration in nation building, its implementation is hampered by a number of issues. Lack of educational resources, untrained teachers, inadequate relevant text books, teachers’ unfavorable attitudes, shortage of improvisational abilities, and a lack of laboratory staff are some of the aggravating problems according to the study (Abah, Mashebe, & Denuga, 2015; Achimugu, 2016; Jegede & Okebukola, 2006; Odo, 2013; Ugwu, 2019).

According to the literature that is currently available, the majority of studies that were conducted focused on issues that hindered effective chemistry teaching and learning, but very few of these studies were specifically designed to evaluate strategies that would make it easier for cultural knowledge and practices to be incorporated into chemistry instruction in secondary schools. There is a dearth of information on the methods that improve the incorporation of cultural practices and knowledge in general chemistry instruction. In light of the importance of understanding how to incorporate cultural knowledge and practices into chemistry instruction for effective chemistry teaching and learning, it is crucial that this study be conducted.
2 Problem of the study

Chemists have been worried about the issue of students’ low performance in chemistry and how to solve the issue. The failure of students to comprehend or understand what they are taught in chemistry classes has been related to underachievement in chemistry (Okoroafor, 2022). In order to connect what pupils do at home with related chemical principles for their better understanding, chemistry teachers have been asked to incorporate cultural knowledge and practices into the teaching of chemistry (Abumchukwu, Eke, & Achugbu, 2021). The integration of indigenous practices into the teaching of chemistry, however, is fraught with difficulties for teachers. To improve meaningful and pertinent chemistry teaching and learning in developing nations, these obstacles must be overcome. What are the techniques for improving the integration of cultural knowledge and practices into the teaching and learning of chemistry in secondary schools, as stated in the form of a question?

3 Purpose of the study

The main purpose of this study was to assess strategies enhancing the integration of cultural knowledge and practices into the teaching and learning chemistry in secondary schools. Specifically the study was designed to:

(1) Find out strategies that can enhance the integration of cultural knowledge and practices into the teaching and learning of chemistry.

(2) Ascertain the factors militating against the integration of cultural knowledge and practices into the teaching and learning of chemistry.

4 Research questions

The following research questions were posed to guide the study:

(1) What are the mean responses that teachers and students consider as strategies that can enhance the integration of cultural knowledge and practices into the teaching and learning of chemistry?

(2) What are the mean responses that teachers and students consider as factors militating against the integration of cultural knowledge and practices into the teaching and learning of chemistry?

5 Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance.

(1) There is no significant difference in the mean responses of teachers and students on strategies that can enhance the integration of cultural knowledge and practices into the teaching and learning of chemistry in secondary schools.

(2) There is no significant difference in the mean responses of teachers and students on factors militating against the integration of cultural knowledge and practices into the teaching and learning of chemistry in secondary schools.

6 Research method

The study adopted survey research design. The design was appropriate because it sought to elicit chemistry teacher’s opinion on factors militating against the integration of cultural knowledge and practices into the teaching and learning of chemistry in secondary schools. In other words, the design does not require the manipulation of variables or arrangement for the event to happen. The area of the study is Kogi State, located in North-central geopolitical zone of Nigeria. The population of the study comprised all the 480 chemistry teachers and 19,440 chemistry students in public secondary schools in Kogi State (Ministry of Education, Science and Technology, Kogi State, Nigeria 2021/2022). Simple random sampling technique based on the already existing three educational zones (Kogi West, Kogi Central and Kogi East) in Kogi State, was used to sample 10% of the population...
(48 teachers and 1966 students) were selected from 480 teachers and 19,660 students respectively. The total respondents were 2014.

The instrument for data collection was a questionnaire developed by the researcher tagged “Strategies that can Enhance the Integration of Cultural Practices Questionnaire” (SEICPQ). It consists of two sections: A and B. Section A measured the demographic variables of the respondents, Section B consisted of 24-item with 4 points likert scale options (strongly agree, agree, disagree and strongly disagree). Cluster 1 contains 12 items addressing research question 1 while cluster 2 contains 12 items addressing research question 2. The instrument was validated by three experts, two in chemistry education and one in measurement and evaluation in the Department of Science Education, University of Nigeria, Nsukka. Their corrections and suggestions resulted in the final draft of the instrument. The instrument was trial tested using 40 other teachers that did not participate in the research but possess the characteristic of the sample. Cronbach alpha was used to determine the reliability of the instrument. The instrument gave an internal consistency reliability estimate of 0.88 which shows that the instrument is reliable. Data collected were analyzed using Mean and Standard Deviation. The t-test was used to test the null hypothesis at 0.05, level of significance. The decision rule for answering research questions was arrived at finding the average of 4-point scale, which gives 2.50. Thus, any item with mean of 2.50 and above was interpreted to be factor/agreed, while mean scores below 2.50 were interpreted to be a non-factor/agreed.

7 Results

(1) Research Question One: What are the mean responses that teachers and students consider as strategies that can enhance the integration of cultural knowledge and practices into the teaching and learning of chemistry? 
(2) Research Question Two: What are the mean responses that teachers and students consider as factors militating against the integration of cultural knowledge and practices into the teaching and learning of chemistry?

Hypothesis 1: There is no significant difference in the mean responses of teachers and students on strategies that can enhance the integration of cultural knowledge and practices into the teaching and learning of chemistry in secondary schools.

Hypothesis 2: There is no significant difference between the mean responses of teachers and students on factors militating against the integration of cultural knowledge and practices into teaching and learning of chemistry in secondary schools.

The data in Table 1 revealed the responses of teachers and students on the strategies that can enhance the integration of cultural knowledge and practices in teaching and learning of chemistry in secondary schools. The data showed that all the mean scores of both teachers and students were above the cut-off point of 2.50. This implies that the respondents agreed that these strategies can enhance the integration of cultural knowledge and practices into the teaching and learning of chemistry in secondary schools.

Table 1: Mean and standard deviation rating of the responses of teachers and students on the strategies that can enhance the integration of cultural knowledge practices.

<table>
<thead>
<tr>
<th>S/N</th>
<th>Items</th>
<th>Teachers</th>
<th></th>
<th></th>
<th>Students</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X</td>
<td>SD</td>
<td>Decision</td>
<td>X</td>
<td>SD</td>
<td>Decision</td>
</tr>
<tr>
<td>1</td>
<td>Incorporation of cultural knowledge and practices into secondary school chemistry curriculum</td>
<td>3.15</td>
<td>0.74</td>
<td>Agree</td>
<td>3.18</td>
<td>0.69</td>
<td>Agree</td>
</tr>
<tr>
<td>2</td>
<td>Creation of free periods and extra time for lessons on cultural knowledge and practices</td>
<td>2.78</td>
<td>0.56</td>
<td>Agree</td>
<td>2.89</td>
<td>0.78</td>
<td>Agree</td>
</tr>
<tr>
<td>3</td>
<td>Designing and making available in secondary schools, the indigenous learning materials</td>
<td>3.98</td>
<td>0.81</td>
<td>Agree</td>
<td>3.64</td>
<td>0.72</td>
<td>Agree</td>
</tr>
<tr>
<td>4</td>
<td>Regular training and retraining of chemistry teachers on the integration of cultural knowledge and practices in teaching chemistry</td>
<td>3.71</td>
<td>0.79</td>
<td>Agree</td>
<td>3.57</td>
<td>0.63</td>
<td>Agree</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>3.76</td>
<td>0.78</td>
<td>Agree</td>
<td>3.40</td>
<td>0.61</td>
<td>Agree</td>
</tr>
</tbody>
</table>
Increase in government statutory allocation of funds to secondary education

Provision of adequate facilities as well as motivation of teachers and students by various means

Active involvement of indigenous people in giving the necessary technical support for cultural integration into teaching and learning

Partnership with industries in order to motivate teachers and students involved in the integration of cultural knowledge and practices in the secondary school chemistry

Collating and disseminating the list of cultural knowledge and practices that relate to chemical concepts as bulletins to various secondary schools

Enlightening the general public/stakeholders on the prospects of integrating cultural knowledge and practices into the secondary school system

Supporting teachers to adopt varieties of innovative (project, demonstration, cooperative, etc.) teaching methods to reach a large population of students

The data presented in Table 2 revealed the analysis of factors militating against the integration of cultural knowledge and practices in the teaching and learning of chemistry in secondary schools. The data showed that all the items except items 2 and 7 for both teachers and students had their mean scores above 2.50 indicating that the integration of cultural practices into teaching and learning chemistry is generally accepted and supported by the teaching and learning community.

Table 2: Mean and standard deviation rating of the responses of teachers and students on the factors militating against the integration of cultural knowledge and practices.

<table>
<thead>
<tr>
<th>S/N</th>
<th>Items</th>
<th>Teachers</th>
<th></th>
<th></th>
<th>Students</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Non-incorporation of cultural knowledge and practices into secondary school curriculum</td>
<td>3.99 0.59 Factor</td>
<td></td>
<td></td>
<td>3.47 0.67 Factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Secondary school chemistry time table does not give room for the integration of cultural instructional knowledge and practices</td>
<td>2.25 0.47 Not a factor</td>
<td></td>
<td></td>
<td>2.48 0.61 Not a factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Indigenous learning materials are not readily available in secondary schools</td>
<td>3.30 0.81 Factor</td>
<td></td>
<td></td>
<td>3.45 0.53 Factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Lack of adequate training of chemistry teachers on how to integrate cultural knowledge and practices into teaching chemistry</td>
<td>3.65 0.58 Factor</td>
<td></td>
<td></td>
<td>3.39 0.73 Factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Limited awareness on the list of chemistry concepts that relate to cultural knowledge and practices in our environment</td>
<td>3.40 0.79 Factor</td>
<td></td>
<td></td>
<td>3.34 0.63 Factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Lack of public acceptability of the idea of integrating cultural knowledge and practices into teaching and learning chemistry on the ground that it is primitive</td>
<td>3.45 0.64 Factor</td>
<td></td>
<td></td>
<td>3.76 0.86 Factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>The problem of a large class affects the integration of cultural knowledge and practice into teaching and learning chemistry</td>
<td>2.43 0.55 Not a factor</td>
<td></td>
<td></td>
<td>2.14 0.61 Not a factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Non-involvement of industries in supporting and motivating teachers and students on the cultural heritage ventures</td>
<td>3.18 0.56 Factor</td>
<td></td>
<td></td>
<td>2.07 0.74 Factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Limited local technical support from the natives on their wealth of cultural knowledge and practices at the classroom implementation stage</td>
<td>2.92 0.62 Factor</td>
<td></td>
<td></td>
<td>3.10 0.76 Factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Unconducive learning environment for the implementation of the integration of cultural knowledge and practices into chemistry teaching and learning</td>
<td>3.08 0.83 Factor</td>
<td></td>
<td></td>
<td>2.93 0.68 Factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Lack of regular and effective monitoring of integration of cultural knowledge and practices into teaching and learning chemistry by head teachers</td>
<td>2.92 0.60 Factor</td>
<td></td>
<td></td>
<td>3.06 0.86 Factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Inadequate funding of secondary education by Government</td>
<td>3.04 0.59 Factor</td>
<td></td>
<td></td>
<td>3.18 0.67 Factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggregate values</td>
<td>3.12 0.64 Factor</td>
<td></td>
<td></td>
<td>3.09 0.70 Factor</td>
<td></td>
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</tbody>
</table>

Bold values implies that in overall both the students and teachers have agreed that the aforementioned are factors militating against the integration of cultural practices into the teaching and learning of chemistry.
respondents agreed that items: 1, 3, 4, 5, 6, 8, 9, 10, 11 and 12 are factors militating against the integration of cultural knowledge and practice in the teaching and learning of chemistry in secondary schools. Items 2 and 7 had their mean scores for both teachers and students, below the cut-off point of 2.50 and hence the respondents disagreed with the two items. That is to say that they are not factors militating against the integration of cultural knowledge and practices in teaching and learning chemistry.

The result presented in Table 3 indicated that $t_{cal}$ is 0.40 which is lower than the $t_{crit}$ value of 1.96. This implies that the null hypothesis is not rejected. Therefore there is no significant difference between the mean responses of teachers and students on strategies that can enhance the integration of cultural knowledge and practices into teaching and learning chemistry.

The result presented in Table 4 indicated that $t_{cal}$ is 0.320 which is lower than the $t_{crit}$ value of 1.96. This implies that the null hypothesis is not rejected. Therefore there is no significant difference between the mean responses of teachers and students on factors militating against the integration of cultural knowledge and practices into teaching and learning chemistry in secondary schools.

## 8 Discussion of findings

The finding with respect to research question one revealed that: incorporation of cultural practices into chemistry curriculum content; adequate training of chemistry teachers on the integration of cultural practices, dissemination of the list of chemical concepts that relate to cultural practices as bulletin to schools; and availability of designed local learning materials were strategies to improve the integration of cultural practice venture; involvement of local people in giving the required technical support at the classroom implementation stage; enlightenment of stakeholders on the prospects of integrating cultural practices; regular monitoring of chemistry teachers; and increase statutory allocation of funds to secondary education can enhance the integration of cultural practices in teaching and learning of chemistry. The results are consistent with those of Olotu and Ugwuanyi (2017), who recommended that indigenous practices be incorporated into the science curriculum and that teachers be given training on how to do so, as well as Indra and Bitwell (2016), who said that teacher training institutions of learning may incorporate the integration of pertinent ethno-chemistry knowledge in chemistry lessons.

The findings with respect to research question two revealed that: non-incorporation of cultural knowledge and practices into of chemistry curriculum contents; chemistry teacher’s limited awareness of chemical concept that can be linked to cultural practices in their environment; inadequate training of teachers on how to integrate cultural knowledge into teaching of chemistry, lack of public acceptability of the integration of cultural practices
in teaching of chemistry and non-availability of relevant learning material on cultural practices of the natives are strong militating factors against the integration of cultural knowledge and practices in the teaching and learning of chemistry in secondary schools. It was also discovered that lack of partnership and support of industries to secondary schools, lack of technical support from the natives, unconducive working conditions of chemistry teachers, ineffective supervision of chemistry teachers and inadequate funding of secondary education militate against the integration of cultural knowledge and practices in the teaching and learning chemistry. These results are consistent with those made by Odo (2013), who noted difficulties in including ethnochemistry in the chemistry curriculum and that the available chemistry teachers were untrained and unable to teach what they did not understand; Abah et al. (2015), who noted that the equipment and technology available were not created with African indigenous science in mind; and Ugwu (2019), who noted that native knowledge of traditional society has been regarded as inferior and retrograde.

The results of research question two also showed that the respondents believed that the problems of large classes and the lack of time in the school schedule for integrating cultural practices were not barriers to integrating cultural knowledge and practices into the teaching and learning of chemistry. The results go against Achimugu’s (2016) claim that a condensed school schedule and big class sizes are barriers to successful chemistry teaching and learning. Perhaps as a result of their understanding of and use in the classroom of the prior research reports/recommendations on the aforementioned two problems, chemistry teachers have been able to overcome these two challenges in the present study.

9 Conclusions

The study has identified methods for enhancing how cultural practices and knowledge are incorporated into chemistry instruction and learning in secondary schools. In addition, despite numerous attempts, the study has pinpointed the issues that make it difficult to include cultural knowledge and practices into chemistry teaching and learning. The study also confirmed that there are no significant differences in secondary school teachers’ and students’ views on the methods that can improve the integration of cultural knowledge and practices into the teaching and learning of chemistry, as well as the barriers to such integration.

10 Recommendations

In order to improve in the teaching and learning of chemistry at secondary school level, the following recommendations are made:
(1) Secondary school chemistry curriculum should be reviewed in order to include the cultural knowledge and practices into the curriculum content.
(2) Secondary school chemistry teachers should be trained on how to integrate cultural knowledge and practices into the teaching and learning of chemistry by Government at various levels.
(3) Natives and local technicians should be involved by making out time to support the training of teachers on the integration of cultural practices into the classroom chemistry interaction pattern.
(4) Chemistry education researchers and other stakeholders should collate the list of chemical concepts that relate to local practices and disseminate the same as bulletin to teachers at their various schools.
(5) There is need to constantly enlighten the general public on the prospects of integrating cultural practices into the teaching and learning of chemistry.
(6) Indigenous learning materials should be designed and made available to chemistry teachers at their various secondary schools.
(7) Industries should be involved in promoting the integration of cultural practices by encouraging and supporting chemistry teachers and students.

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