Asian Journal of Education and Social Studies

14(4): 13-25, 2021; Article no.AJESS.64763
ISSN: 2581-6268

Factors Influencing Teaching of Chemistry in Class Nine and Ten in the Schools under Chhukha District, Bhutan

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Authors' contributions

This work was carried out in collaboration between both authors. Author NC designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author NW managed the analyses and literature searches. Both the authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJESS/2021/v14i430360
Editor(s):
(1) Dr. Vlasta Hus, University of Maribor, Slovenia.
Reviewers:
(1) Cojocariu Venera-Mihaela, Vasile Alecsandri University of Bacău, Romania.
(2) Petre Cristian, Ovidius University of Constanta, Romania.
Complete Peer review History: http://www.sdiarticle4.com/review-history/64763

Original Research Article

Received 15 November 2020
Accepted 14 January 2021
Published 06 February 2021

ABSTRACT

This study investigated the factors influencing the teaching of chemistry in class nine and ten in the schools under Chhukha District, Bhutan. Adopting convergent mixed method design, the study employed structured questionnaire to collect quantitative data and semi-structured interview and classroom observation to collect qualitative data. The sample comprised of 10 Chemistry teachers and 500 students from class nine and ten from three middle secondary schools and two higher secondary schools. Quantitative data were analyzed using descriptive statistics in the form of tables, mean and standard deviation whereas the qualitative data were analyzed based on content analysis technique. The findings of this study highlighted that the lack of laboratory resources, limited time allocated for chemistry theory and practical classes, and teachers' heavy workload impacted teaching of chemistry negatively while the teacher's sound knowledge on the chemistry subject impacted the teaching of chemistry positively.

Keywords: Practical; laboratory; workload; attitude; class-size; pedagogy; chemistry.

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1. INTRODUCTION

Bhutan is a small landlocked country in Southeast Asia sandwiched between the world's two most populous countries— China and India. With the inception of the modern education system in 1961 Bhutan introduced a borrowed science education curriculum from India into the Bhutanese schools. The earlier versions of science curriculum which were adopted from outside countries have undergone several revisions at different times, in various ways in order to provide better education for the Bhutanese citizens.

The teaching of science in general and chemistry in particular, is to help students develop an understanding of the natural world and its phenomena from a scientific approach. It has been observed that due to the abstract nature of chemistry and the lecture method being used by teachers to teach the subject most students fear chemistry and hence they see chemistry as difficult to understand [1].

Chemistry has been identified as a very important science subject as it is important in scientific and technological development of the nation. However, students consider chemistry as a very conceptual and difficult subject to learn. A subject could be regarded as abstract or difficult if it requires on the average higher reasoning to understand [2]. It is common in Bhutanese classrooms to hear students referring to chemistry as being difficult and abstract. Bhutanese students consider science as a difficult subject to teach and learn [3].

The abstract nature of chemistry and the ineffective teaching method used by the teacher to teach the subject leads to the students 'poor performance in chemistry. The study by [4] shows that teacher's negative perception of their learners' abilities, inadequate use of resources in teaching and learning process, negative socio-cultural factors and inappropriate learning environment were the main causes of the students' persistent poor performance in chemistry.

Teachers are the single most important factors in improving the classroom interaction which decides the performance of students in the subject. The widespread poor performance and the students' negative attitudes towards chemistry of secondary school have been largely ascribed to teaching problems [5]. The problems facing teaching of chemistry includes laboratory inadequacy, teachers' attitude, and time constraint for practical, non-coverage of syllabus, class size, non-professionalism and environment [6].

Despite the efforts made by the Royal Government of Bhutan to improve chemistry curriculum, the findings indicate that the level of chemistry achievement, among other science subjects, has remained persistently low as indicated from the Bhutan Certificate of Secondary Education (BCSE) examination record for the year 2018 and 2019 as shown in Table 1. The poor performance in sciences especially in chemistry has continued to be a major concern for the government and other stakeholders in education in Bhutan.

It is on the basis of this that this study was undertaken to investigate how school factors (class size, laboratory adequacy, teachers' workload and adequacy of time), teacher factors (teacher's content knowledge in chemistry and use of teaching pedagogy) and student factor (attitude towards chemistry) influences teaching of chemistry in class nine and ten in the middle and higher secondary schools under Chhukha district.

2. LITERATURE REVIEW

Literatures pointed out numerous factors that influence the teaching of chemistry for classes nine and ten students. The factors considered in this study are school factor, teacher factor and student factor. School factor is associated with the laboratory resources, class size, and time allocated for chemistry teaching, and teachers' workload. Teacher factor include teachers' content knowledge, teaching pedagogy and the student factor which is associated with the students' attitude towards chemistry. The detail literatures for each of the factor is discussed below

2.1 Laboratory Resources

Laboratory as teaching resources including teaching aids are essential in order to make teaching effective and meaningful. These resources help the teachers to communicate information effectively to the learners thus making the complicated concepts more realistic and clear. The use of teaching resources in the teaching helps increase the learners' motivation. The use of new technologies increases students' motivation and facilitates the transmission of information to students [7].

Table 1. Bhutan certificate of secondary education (BCSE) 2018 and 2019 examination overall performances in chemistry compared with other science subjects

Subject	National subject wise mean mark (2018)	Chukha district subject wise mean mark (2018)	National subject wise mean marks (2019)	Chukha district subject wise mean mark (2019)
Biology	34.30	50.73	43.00	52.57
Chemistry	28.00	45.29	33.70	45.58
Physics	36.50	53.36	39.35	47.76

(Source: Pupil performance report for 2019 & 2020 BCSE Examination)

According to the study by [8] on investigating the relationship between chemistry laboratory work and students' academic performance in chemistry revealed that there was a significant relationship between use of laboratory and students' academic performance in chemistry. The school whose teachers took their students for the practical lessons recorded higher performance in practical while those schools whose teachers did not take their students for practical lessons recorded low performance. The learning and understanding level of students in science improved when the students are involved in practical works in the laboratory [9].

2.2 Teacher's Workload

Workload refers to the amount of work that has to be done by a particular person or organization. As per the study conducted by [10] on the effect of teachers' workload on students' academic performance in community secondary school in Tanzania revealed that there is a relationship between teachers' workload and students' academic performance. This finding corroborated the finding by [11] that teachers' heavy workload hindered students' academic performance. Similarly, [12] pointed out that teacher's workloads affect students' performance.

According to [13], the increases in the number of students in the class result in the increased teacher's workload. The teaching of overcrowded classes leads to excessive marking of student's work. In addition, [14] study on workload of technical secondary school teachers in Malaysia reported that when the teachers have to teach class with more students, the teachers are unable to develop materials for teaching and as a result lack innovation in teaching and learning.

2.3 Time Allocated for Teaching Chemistry

Adequacy of time allocated for teaching refers to the total amount of time available for teaching and learning of chemistry lessons in the schools. The study conducted by [15] with 65 students and 10 chemistry teachers to investigate the challenge of effective teaching of chemistry in Nigeria found that time constraint is one of the major factors responsible for the students' poor performance in chemistry. Similarly, the finding from the study conducted by [16] on factors influencing effective teaching of chemistry in South Africa showed that the lack of adequate practical periods for chemistry affects the effective teaching of chemistry lessons.

2.4 Teachers' Content Knowledge

According to [17] subject matter knowledge is the teacher's understanding of the central concepts, tools of inquiry, and structures of the discipline(s) he or she teaches and creates learning experiences for learners to assure mastery of the content. The quality of education depends on the quality of teachers. The study conducted by [18] showed that the teachers' participation in outreach program, science in action helped them gain confidence in being able to teach science with their understanding of the scientific method and science content. Research also showed that subject matter knowledge of the teachers' influences effective teaching and it is an important predictor of student learning [19, 20].

2.5 Students' Attitudes towards Chemistry

According to [21], attitude is the way students behave and think. Attitudes do not remain static but it can be changed through the learning process such as by using appropriate materials and teaching techniques. Teachers suggested that attitudes toward science can affect students' feelings and attitudes towards science. Students who were found to have positive attitudes in their science class were said to be influenced by their teachers' positive attitudes in science [22]. This is proven by the study of [23] whose finding

revealed that the students' positive attitude was influenced by the teachers' interest in teaching science. On the other hand, the students' negative attitude towards the subjects affects the teachers' effectiveness in teaching. The study by [24] on factors affecting performance in chemistry in public secondary schools in Kenya showed that students have a negative attitude towards chemistry although they are interested in careers that demand the knowledge of chemistry. The study also revealed that students' attitude towards the subject affected their performance in the subject. Students who have negative attitudes towards chemistry perform poorly than those with positive attitude [25].

3. METHODS

The study used mixed method involving both qualitative and quantitative research approaches. Mixed method research involves the integration of quantitative and qualitative research in a research study [26]. Both qualitative and quantitative approaches were used in this study in order to maximize the quality of the data that were collected. The researchers collected both forms of qualitative and quantitative data at the same time involving the convergent parallel mixed method.

3.1 Population and Sampling

The population of this study consisted of students of class nine and ten and chemistry teachers teaching from three Higher Secondary Schools and six middle secondary schools under Chukha district, western Bhutan. Simple random sampling technique was used to select the sample of student respondents. A sample of 100 students from each sample school which comprised 50 students each from class nine and ten with almost equal proportion of male and female from both the classes were selected. However, a convenience sampling technique was used to select the chemistry teacher participants. A sample of 2 chemistry teachers each who taught and was teaching chemistry in class nine and ten were selected from each sample school.

3.2 Data Collection Methods and Instruments

The researcher used various instruments to capture information for the purpose of the study. This includes questionnaire, classroom observation and interview as discussed below.

3.2.1 Questionnaires

A list of structured questions was given to the respondents to answer. There were two categories of questionnaires; the questionnaires for students and the questionnaires for teachers. Both the questionnaire for the teachers and the students was based on the 5-point Likert-type scale of strongly agree, agree, neutral, disagree and strongly disagree.

The questionnaire for teachers was used to explore teachers' opinions about how the school factors (class size, availability of laboratory resources, teacher's workload and time allocated for teaching chemistry), teachers' factors (teaching pedagogy employed by the teacher to teach and teachers' knowledge of the chemistry subject) and the students' factors (student's attitudes towards chemistry) influence the teaching of chemistry in class nine and ten.

3.2.2 Interview

For this study, the semi-structured interview was used as it allows covering various issues concerning the study. The semi-structured interview is a more flexible version of the structured interview in which the researcher prepares the limited number of questions in advance and plans to ask follow-up questions to the interviewee during the interview [27].

3.2.3 Classroom observation

The class observation in addition to questionnaire and interview was used as a tool to gather information since it enabled the researcher to capture information from the actual settings. Classroom observations as an instrument for the data collection for the study was used to observe teaching pedagogy used by the teachers during their lesson delivery and observe the class size and its effects in teaching chemistry. Observation helps researchers to obtain a valid and credible picture of phenomena being studied [28]. During observation the researcher assumed the role of non-participant observer, using eyes to observe and record events of relevance to the study.

3.2.4 Data collection procedure and analysis

For the purpose of the data collection, the researcher sought permission from the District authority and school principals and informed them about the proposed study. The purpose of

the study was explained to the respondents prior to the data collection. The questionnaires were administered to the selected teachers and students after school hours without interfering with the school normal schedule.

Quantitative data analysis was based on descriptive statistics. Data analysis began by coding the data according to the research questions. The data was then entered into the computer using the Statistical Package for Social Sciences (SPSS) program for analysis. Furthermore, the data were presented using tables, mean, and standard deviations and were interpreted inductively based on research objectives.

The response of the interviewees was transcribed, coded and the data were categorized under specific themes and analyzed using content analysis technique. This approach essentially involves a thorough and repeated reading of all the responses of each respondent, underlying the main ideas and then extracting the core meaning under each theme. The data were presented by using summaries, explanations, descriptions and deductively interpreted based on research objectives.

4. RESULT ANALYSIS

The result analysis was carried out based on each of the factors as discussed below.

4.1 Laboratory Resources

The analysis of teachers' overall rating on the availability of laboratory resources in their school is faintly moderate with a score of (M =2.85; SD = 1.86) as reflected on Table 2. However, in terms of the availability of separate chemistry laboratory, the rating is low with the score of (M =2.60; SD =2.06). This indicated that there was no separate laboratory in the schools.

The analysis of teachers' interviews too showed that most of the schools did not have separate chemistry laboratories. For example, Teacher 5 expressed that; *We do not have separate chemistry laboratories. We have one general science laboratory for biology, chemistry and physics. The apparatus and chemicals are also inadequate.*

The lack of separate chemistry laboratory and inadequate apparatus and chemical was the reason why teachers skip practical lessons and this has hindered student's learning in chemistry as expressed by T1: Due to the lack of a separate chemistry laboratory, the practical lessons cannot be conducted which leads to children poor understanding of chemistry concepts and low level of motivation for learning.

It was also evident in most of the lessons observed by the researcher that the practical lessons were conducted in the classroom in the form of demonstration. Students sitting at the back were not able to see the teacher demonstration and they did not pay much attention to the teacher. Therefore, demonstration of experiments was not as effective as it would have been if the students were actively engaged in individual experiments in the laboratory. The classroom observation notes also revealed that three of the five schools (i.e., school A, B & C) did not have separate chemistry laboratories. These schools that did not have separate chemistry laboratories had one general laboratory for biology, chemistry and physics which was poorly equipped.

4.2 Class Size

From Table 3, the overall score of teachers' rating on the effect of class size in teaching chemistry is low with an average mean of (M=2.32; SD =1.22). This indicates that the class size influences the effective teaching of chemistry negatively. For instance, owing to huge class size, the teachers were not able to give one to one guidance to students in chemistry lessons (M =1.80), attend to student's work on time and provide feedback (M=2.30), organize group activity (M=2.40), and conduct individual practical (M=2.60) as reflected on Table 3.

Table 2. Teachers' rating on availability of chemistry laboratory resources

Sl. no	Items	Mean	SD	Level of agreement
1	The school have separate chemistry laboratory	2.6	2.06	Low
2	The apparatus and chemicals in the laboratory are adequate for chemistry lessons.	3.1	1.66	Moderate
	Total	2.85	1.86	Moderate

Table 3. Teacher's response on effect of class size in teaching

Sl. no	Items	Mean	SD	Level of agreement
1	I am able to give one to one guidance to students in chemistry lessons because of the small sized class.	1.80	1.22	Lowest
2	I am able to correct student's work on time and provide constructive feedback to students' work owing to small sized classes.	2.30	1.49	Low
3	It becomes easy for the conduction of practical due to small class size.	2.60	1.1	Low
4	I am finding it easy to organize group activities because of the small class size.	2.40	1.0	Low
5	It becomes easy for me to demonstrate the experiments due to small class size.	2.50	1.17	Low
	Total	2.32	1.2	Low

Similar findings were also evident from the teacher interview. The large class size was found to be causing a lot of problems in the teaching and learning of chemistry. Most of the teachers (teachers of schools A, C & D) responded that they have large class size and shared the difficulties associated with it. For instance, Teacher 5 expressed that: There are no less than 39 students in each class I am teaching. Some of the classes have even 44 students in it. The classroom is very small with a huge number of students in it. It is very difficult to move in the class because the classroom is very small.

Further, it also affects student- teacher interactions. Similarly, the difficulties of having large class size were also observed during the classroom lesson observation. Due to large class size, teachers were not able to incorporate appropriate teaching pedagogy in teaching and the students sitting at the far end of the classroom were not able to read the letters written on the board by the teacher. The note on classroom observation also reveals that most of the schools that were visited had more number of students in the class than the space available.

4.3 Teachers' Workload

Table 4 reveals that the overall score on teachers' rating on the effect of workload in teaching chemistry was high with an average mean score of (M =3.75; SD =1.0). There were six items in this category and all the items had a high mean score. For instance, the administrative roles in addition to more instructional periods was a cause of teachers' heavy workload with the high mean score rating of (M =4.10; SD =0.56) as reflected on Table 4.

The findings from the teacher's interview too confirm that the more number of teaching periods allocated to teachers per week in addition to the additional administrative roles carried by the teacher led to teachers' heavy workload. The number of instructional hours allocated to teachers in these five schools ranged from 21 to 28 periods per week besides other responsibilities. Majority of teachers (83.3%) in the interview complained that they have heavy teaching load.

For instance, T5 stated that: "I am having 28 periods a week. I am also a club coordinator, house master, class teacher, discipline committee and time table committee members". The above views were echoed by T1 when he expressed: We do not get enough time to prepare chemistry lessons and to work on academic side due to heavy teaching load and increase responsibilities besides teaching.

4.4 Time Allocated for Teaching Chemistry

Chemistry subject were allocated with two different sets of periods with different time duration for a period in the schools where the study was conducted. In some of the schools, the number of periods allocated was 4 of 40 minutes' duration per week while it was 3 periods of 55 minutes per week in some schools. However, the total time period allocated altogether for the chemistry subject was equal. The teachers' overall rating on the adequacy of time allocated

for teaching chemistry in the schools was low with an average mean score of (M =2.1; SD =0.93) as reflected on Table 5. There were three items in this category and all the items had low mean score. This indicates that the number of periods and time allocated was not adequate for effective teaching of chemistry in the schools.

Majority of the teachers (66.6%) during the interview also responded that the time and number of periods allocated for chemistry lessons was not enough for the completion of syllabus unless they do take extra class after the class hours or during weekends. As a result, teachers were not able to devote enough time for practical for the better understanding of the scientific concepts by the students. For instance, T6 expressed that: Students are excited to work on with the equipment in the laboratory when taken to the laboratory. However, due to time constraint most of the practical lessons are virtually shown through video lessons in the class.

4.5 Teachers' Knowledge of their Subject Matter in Chemistry

According to the students' rating on teachers' knowledge of the subject matter as reflected on Table 6, the overall score was highest with the mean score of (M =4.5; SD =0.73). There were four items in this category and all the items were rated very high. This clearly indicates that the chemistry teachers have the required knowledge in chemistry subjects.

Similarly, the teachers' overall rating on their knowledge of subject matter is also very high with a mean score of (M =4.17; SD =0.98) as shown on Table 7. For example, these teachers have required content knowledge to teach chemistry (M =4.50; SD = 0.70), they find it easy to prepare chemistry lessons (M =4.40; SD = 0.69) and easy to teach chemistry (M =3.90; SD =1.37).

4.6 Teaching Pedagogy

The overall score of students' rating of teaching pedagogy used by their teachers in teaching chemistry is low with a mean score of (M =2.58; SD =1.35) as presented on Table 8. The data reveals that the dominant pedagogy used was lecture method (M = 3.43; SD =1.37) and the use of student friendly approaches such as group work (M = 2.43; SD =1.44), practical work (M = 2.46; SD =1.36), and integration of technology in chemistry education (M =2.43; SD =1.40) was minimal as reflected on Table 8.

The analysis of teachers' interviews concurs with that of the quantitative data discussed above. For instance, most of the teachers (66.6%) expressed during the interview that they use lecture method most of the time though it is not very effective in teaching.

Table 4. Teachers' rating on effect of workload in teaching chemistry

Sl. no	Items	Mean	SD	Level of agreement
1	I have too many duties other than instruction of students.	4.1	0.56	High
2	In order to manage workload pressures, I use lecture methods in teaching chemistry to save time.	3.8	0.91	High
3	I have too much administrative paperwork which hinders effective teaching of chemistry.	4	1.15	High
4	Due to too much workload I do not get time to prepare adequately for chemistry lessons	3.7	1.25	High
5	Due to too much workload I do not get time to prepare adequately for the chemistry practical lessons.	3.4	0.96	High
6	I am unable to develop materials for teaching chemistry as I have more number of classes to teach.	3.5	1.17	High
	Total	3.75	1.0	High

Table 5. Teachers' rating on adequacy of time allocated for teaching chemistry

Sl. no	Items	Mean	SD	Level of Agreement
1	The number of periods and time allocated for chemistry lesson is enough for effective teaching of chemistry.	2.30	1.05	Low
2	The number of periods and time allocated for practical works is adequate.	1.90	0.87	Low
3	Time allocated is adequate to cover the subject content of chemistry.	2.10	0.87	Low
	Total	2.1	0.93	Low

Table 6. Students' assessment on teachers' knowledge of the subject matter

Sl. no	Items	Mean	SD	Level of Agreement
1	Teacher has a good knowledge of chemistry as a subject.	4.55	0.63	Highest
2	My chemistry teacher always comes prepared to the class.	4.55	0.73	Highest
3	The teacher is confident in teaching chemistry.	4.53	0.73	Highest
4	My chemistry teacher has answers to any chemistry questions asked by the students in the class.	4.37	0.84	Highest
	Total	4.5	0.73	Highest

Table 7. Teachers' response to their competency in teaching chemistry

Sl. no	Items	Mean	SD	Level of Agreement
1	I always find it easy to prepare chemistry lessons.	4.40	0.69	Highest
2	To be a chemistry teacher is an easy job.	3.90	1.37	High
3	I have the required qualification to teach chemistry.	4.50	0.70	Highest
4	I am in the teaching profession by choice.	3.90	1.19	High
	Total	4.17	0.98	High

Table 8. Students' rating on the use of teaching pedagogy by their chemistry teacher

Sl. no	Items	Mean	SD	Level of Agreement
1	We are often made to work together in pairs or small groups in chemistry class.	2.43	1.44	Low
2	My chemistry teacher takes us to the laboratory for practical work at least once a week.	2.46	1.36	Low
3	My chemistry teacher teaches us using lecture methods most of the time.	3.43	1.37	High
4	My chemistry teacher demonstrates experiments to teach chemistry concepts most of the time.	2.17	1.22	Low
5	My chemistry teacher teaches chemistry with integration of technology.	2.43	1.40	Low
	Total	2.58	1.35	Low

The reasons cited by the respondents for excessive use of lecture method were time constraint and vast syllabus. T2 expressed that they resort to lecture method in teaching chemistry when the time period allocated is not sufficient for the lesson to be taught. For instance; Teaching chemistry concepts with practical activities takes lots of time and therefore, it is very difficult to complete the syllabus on time. So when there is no time then I land up using lecture method in teaching chemistry which helps me complete the lesson faster (Teacher 2).

It was also evident from the classroom observation that the lecture method was the most commonly practiced teaching pedagogy by the teachers. For instance, 87.5% of the chemistry teachers used lecture method while 7.5% used questions and answer methods, and only 2.5% used class discussion and practical methods.

4.7 Student's Attitude towards Chemistry

As reflected on Table 9, the students' overall rating on their attitude towards chemistry is low with a mean score of (M =2.34; SD =1.27). This shows that the students' attitude towards chemistry is negative. For instance, students find chemistry less easy compared to other subjects (M=2.42; SD=1.21), they neither enjoy learning chemistry (M=2.26; SD=1.35) nor wants to spend more timing reading chemistry books (M=2.32; SD=1.31), and they find concepts, theories and formulae in chemistry difficult to comprehend (M=2.0; SD=1.23) as reflected on Table 9.

Similarly, the finding from the teacher survey questionnaire on the influence of student factor in teaching chemistry is high with a mean score of (M =4.12; SD =0.89) as shown on Table 10. This shows that the students' negative attitudes towards chemistry influence the teaching of chemistry negatively. For example, most of the students perceive chemistry as a difficult subject (M =4.30; SD =0.94), students have psychological fear of chemistry (M =3.90; SD =1.19) and as a result of student loss of interest in chemistry retards effective teaching of chemistry (M =4.70; SD =0.48).

Table 9. Student's response to their attitude towards chemistry

Sl. no	Items	Mean	SD	Level of agreement
1	I think chemistry is an easy subject compared to other subjects.	2.42	1.21	Low
2	I enjoy learning chemistry.	2.26	1.35	Low
3	I am willing to spend more time reading chemistry books.	2.32	1.31	Low
4	I like chemistry more than any other subjects.	2.53	1.17	Low
5	I like to solve mathematical problems in chemistry.	2.55	1.38	Low
6	The concepts, theories and formulas of chemistry are easy to understand as compared to other science subjects.	2.0	1.23	Low
	Total	2.34	1.27	Low

Table 10. Teachers' rating on the influence of student factors in teaching chemistry

Sl. no	Items	Mean	SD	Level of agreement
1	Students' loss of interest in chemistry retards effective chemistry teaching.	4.70	0.48	Highest
2	Students have psychological fear of chemistry.	3.90	1.19	High
3	Most of the students perceive chemistry as a difficult subject with many theories.	4.30	0.94	Highest
4	Students easily get discouraged by the poor outcome of their results.	3.60	0.96	High
	Total	4.12	0.89	High

Similarly, in the interview, majority of the teachers too revealed that the students find chemistry difficult and this has resulted in the development of negative attitude towards the subject. For instance, T6 expressed that: Student have negative attitude towards chemistry. They usually find the subject difficult and as a result they develop fear in the subject. And because they lack interest in the subject they fail to do well in chemistry.

The students' poor attitude to the subject has de-motivated the teachers from working hard. For instance, T2 and T3 expressed that; "the students' negative attitude towards the subject de-motivate to teach while their positive attitude motivates us to work hard".

5. DISCUSSION

This study revealed that three out of five schools did not have separate chemistry laboratories. The general science laboratory meant for biology, chemistry and physics was not well equipped. The lack of separate chemistry laboratory, non-availability of required chemicals and apparatus and time constraint has hindered carrying out practical works. Similar findings to this were also reported in the study [29] in Afar region in Ethiopia; [30] in Nigeria and [31] in Bhutan that the absence of separate and well equipped laboratory for science hinders the carrying out of practical activities in science.

The findings from this study also suggest that the implication of not carrying out the practical lessons has led to student's poor understanding of chemistry concepts. This is consistent with the study conducted by [9] in Punjab who concluded that the learning and understanding level of students in science improves when they are involved in practical works in the laboratory. Similarly, the study by [32] in Turkey pointed that the use of laboratories has the potential to enhance students' achievement, conceptual understanding and their positive attitudes. Further, the study by [33, 30] showed that the lack of separate chemistry laboratories in schools hinders students' effective learning of chemistry.

From this study, it was observed that large class size has hindered effective teaching and learning of chemistry. For instance, the study revealed that it becomes very difficult to conduct practical lessons, organize group activities and demonstrate the experiments when the class size is large. This agrees with the finding of [6] study that it is difficult to demonstrate the experiments when the class size is large as the teacher had to spend a lot of time controlling the class.

It is revealed time constraint as one of the major factors that influences the effective teaching of chemistry. The finding from this study showed that the time allocated for the subject was not adequate for teachers to cover the stipulated content. The teacher has to adjust the practical class from the period allocated for the theoretical class as there was no separate period allocated for the practical lessons. The teachers were not able to carry out practical lessons within the time limit of three periods allocated for both the theoretical classes and practical classes combined. This finding can be related well to [6].

In this study, class size was the main cause of teacher's workload as evident from the teachers with more students work to correct, prepare teaching aids and prepare for practical lessons. The finding from this study is consistent with the study conducted by [14] in Malaysia who concluded that the teachers are unable to develop materials for teaching because of large class and as a result lack innovation in teaching and learning.

In addition, the findings from this study also indicated that the teaching pedagogy adopted by the teachers in teaching chemistry affected the teaching of chemistry. For instance, the teacher in this study resorts to lecture method owing to vast syllabus and time constraint. Teachers were also not able to incorporate experimental teaching pedagogy in chemistry lessons due to lack of separate chemistry laboratory and lack of adequate laboratory materials. The finding from this study is in agreement with the study conducted by [34] in Finland that the science teachers in the school were not able to implement experimental teaching pedagogy effectively due to lack of resources in school.

Furthermore, the result from this study indicated that students' have negative attitudes toward chemistry. For instance, this study revealed that students perceived chemistry concepts, theories and formulas as difficult and abstract to learn. This is in agreement with the findings of [35] who pointed out that students found chemistry difficult. As a result students disliked science in general because of chemistry. This finding is also in agreement with the study finding of [1] in

Ethiopia who found out that course content among others as one of the factors that cause students' fear in chemistry.

The findings also suggest that the pedagogical aspect of teaching and learning to be considered as the student's attitude towards the subject is influenced by the method the teacher uses in teaching. This is in line with the study conducted by [23] and [1] in Ethiopia that the students' positive attitude is influenced by the teachers' interest and effectiveness in teaching science. Students' loss of interest in chemistry has affected the effective teaching of chemistry as the student's negative attitudes toward the subject de-motivate the teachers. Student attitudes towards science affect students' participation in science subjects and impacts in science. The finding from this study is also supported by the study conducted by [36] in Kenya which pointed out that the students' negative attitudes towards the subjects affect the teachers' effectiveness in teaching.

6. CONCLUSION

In the light of research findings, the following conclusions are drawn. The study revealed that the school based factors such as non- availability of laboratory resources, teacher's heavy workload, large class size and inadequate time allocated to chemistry teaching exert remarkable influence on teaching of chemistry negatively.

The teacher's heavy workload and large class size was another factor that influenced teaching of chemistry negatively. The teacher's administrative responsibilities besides teaching loads and the large class size contributed to teachers' heavy workload. As a result, teachers were left with less time to prepare lessons, develop teaching aids, and attend to student's work. The inadequate time allocated for teaching chemistry was found to be the key factor that affects teaching of chemistry effectively. Teachers were not satisfied with the time allocated for teaching chemistry in the schools. The time allocated for chemistry was inadequate to cover the syllabus, conduct meaningful practical and prepare chemistry lessons.

Teachers were also found not incorporating effective teaching pedagogy like experimental teaching methods in chemistry lessons due to lack of separate chemistry laboratory and inadequate laboratory materials. It was found that the lecture method was the most common method used to teach chemistry lessons which were found ineffective in teaching the concepts in chemistry. Inadequate time allocated for chemistry teaching, large class size and non-adequacy of laboratory resources contributed to the use of lecture method in teaching chemistry lessons.

Students' negative attitude towards learning chemistry is also one of the factors that emerged from this study. The negative attitude toward chemistry was due to the difficult nature of the chemistry subject. The students' negative attitude toward chemistry has affected the effective teaching of chemistry as the student's negative attitudes toward the subject de-motivated the teachers.

CONSENT AND ETHICAL APPROVAL

Ethical Research clearance letter for this study was obtained from the Chief District Education Officer (CDEO) of Chhukha District. The clearance letter introduced the researcher to the principals in the schools who in turn, introduced the researcher to the teacher and student participants. As per international standard or university standard, respondents' written consent has been collected and preserved by the authors.

ACKNOWLEDGEMENT

We would like to thank District Education Officers and Principals of the schools for granting permission for us to carry out the data collection process. In addition, we also offer our heartfelt thanks to all the participants for your contribution for this study. Thank you one and all.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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DOI:doi.org/10.3926/jose

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/64763