CHEMISTRY ANXIETY OF SENIOR UNIVERSITY STUDENTS IN ETHIOPIA: THE CASE OF FIVE UNIVERSITIES

[1]Woldie Belachew, [1]Chala Regassa, [2]Birhanu Eribo

[1]Addis Ababa University, ETHIOPIA
[2]Wachemo University, ETHIOPIA

Abstract. This study explores the chemistry-anxiety of third year chemistry students. The objectives of the study were to determine senior university students' chemistry anxiety levels and the relationship among the scales of chemistry anxiety. The sample for this study consisted of 234 (Average Age=21.9 years) third year chemistry students from five universities (Addis Ababa University, Wachemo University, Wolaita Sodo University, Adama Science and Technology University and Arbaminch University). These students completed the Derived Chemistry Anxiety Rating Scales (DCARS) properly. The DCARS was used to judge the anxiety of chemistry students. Quantitative analyses were carried out to analyze the data. The results of analyses revealed that the third year university chemistry students were a little bit to moderately anxious in Chemistry Anxiety (the whole scale) in three of the five universities; a little bit to moderately anxious in learning chemistry anxiety in four of the five universities; a little bit to moderately anxious in Chemistry Evaluation Anxiety in three of the five universities and a little bit to moderately anxious in Handling Chemicals Anxiety in three of the five universities. However, the students exhibited Moderately to very anxious level of anxiety in Chemistry Anxiety (the

whole scale) in two of the five universities, Moderately to very anxious level of anxiety in learning chemistry Anxiety in one of the five universities, Moderately to very anxious level of anxiety in Chemistry Evaluation Anxiety in two of the five universities, and Moderately to very anxious level of anxiety in Handling Chemicals Anxiety in two of the five universities. Besides, correlation analyses indicate significant positive correlation coefficients among the DCARS and subscales. Based on these results, discussions and conclusions were made.

Keywords: university, anxiety, chemistry learning, chemistry evaluation, handling of chemicals

Introduction

Learning furnishes learners with the knowledge which helps them in future life. Learning in general and Learning chemistry in particular are influenced by diverse factors. There are a wide variety of factors that might test a learner's resilience or make the process of learning precarious and problematic (Mathew, 2015). Though there are cognitive factors which influence learning, it is not immune from the influence of affective factors like anxiety. Learning with understanding can be influenced by different situations like the environment in which learning takes place, which can lead learners to sense of anxiety. Anxiety is normal phenomena and may be helpful in learning. Anxiety is a feeling of dread and apprehension (Seckena & Seyhanb, 2015). Anxiety is a normal and often healthy emotion (Browne, 2021). It is a normal and inevitable reaction to a perception of vulnerability or jeopardy (Mathew, 2015). However, high level of anxiety hinders performance of students in science areas like chemistry (Udo et al., 2004). Learners' anxiety towards the learning of chemistry and chemistry laboratory undertakings makes them lose curiosity in chemistry related tasks (Keeves & Morgenstern, 1992).

Chemistry related anxieties can occur due to different reasons. Chemistry anxiety can occur due to previous experiences which are not good, meeting chemistry anxious teachers, lack of role models in chemistry, gender and racial labeling, and stereotyping of scientists (Mallow et al., 2010). The teaching approach applied by teachers contributes in this regard. Many instructors use lecture approach to deliver the subject matter knowledge to their students (Leonard, 2000). Particularly in the early years of post-secondary education, poor teaching seems to produce negative attitudinal effects (Nativa, 2000). According to Nativa (2000) it decreases their positive attitude toward, self-confidence in, and motivation for learning the material and lowers their performance on course tests while increasing their anxiety during studying. Teaching approaches used by teachers can have the potential to make leaners anxious. When the instructional practice goes wrong, students start dreading and begin making all sorts of errors which unpleasantly affects the performance in all subjects including chemistry (Arem, 2010; Seckena & Seyhanb, 2015). Unquestionably there are teacher who have ample experience but could not teach effectively through motivating learners. There are very well-qualified instructors/professors who really understand their subject but cannot help others in a user-friendly manner (Dillon & Maguire, 2007). Situations which lead to dread have clear symptoms which can be negative, emotional, mental, and/or physical reactions (Arem, 2010).

Therefore, teachers should know students level of anxiety for proper intervention. Working on strategies that minimize anxiety is important. Anxiety is experienced by learners not only by teacher-related factors but also problems on the side of learners themselves. Two learner related problems that lead to anxiety are poor background of learners on the subject they learn and ill preparation for the course they are going to take/learn (Arem, 2010). It is important to consider both teacher and student related factors while considering anxiety reduction to make learning effective.

Chemistry anxiety could be described in terms of three subscales (Eddy, 2000). These are fear of chemistry as a course, fear of chemistry evaluation and

fear of chemicals. Fear of chemistry as a course or subject can be due to teachers teaching strategies and/or due to student related problems (Arem, 2010). Anticipating a test situation and experiencing it can be a cause for fear of chemistry evaluation (Zeidner, 1998). Also underutilization of formative assessment practices can lead to anxiety of chemistry evaluation (Goubeaud, 2010). Fear of chemicals occurs when there is problem of understanding of chemical concepts, problem in using reasoning skills, and laboratory skills related problems (Bowen, 1999).

Obviously the onus of considering every factor is on instructors or teachers side. This is conceivable when teachers have empirical substantiations on the anxiety of their students. However, there is paucity of study that focuses on chemistry-anxiety (Melaku et al., 2013) of university students in Ethiopia. Literature confirms that there is pervasiveness of anxiety among adolescents (Davis & Compas, 1986). As university students are adolescents knowing their anxiety level helps in adjusting things in teaching learning process. Thus, the present study focuses on chemistry anxiety of university undergraduate students who are in their senior classes.

Objectives and research questions

The objectives of the study were to determine senior university students' chemistry anxiety levels and the relationship among the scales of chemistry anxiety. To attain these purposes, the research questions were: (1) what is chemistry anxiety level of third year undergraduate students in Ethiopian Universities; (2) what is the association between the chemistry anxiety Scale and chemistry anxiety sub-scales.

Method

Instruments

Derived Chemistry Anxiety Rating Scale (DCARS) was used in study. DCARS is a 36 Likert-type-items-instrument with three subscales. The DCARS

(Appendix) used in this study was adapted from relevant literature source (Eddy, 2000). The DCARS has three subscales of chemistry anxiety: anxiety associated with learning chemistry (17 items), being evaluated in chemistry (9 items) and handling chemicals (10 items). Anxiety levels in DCARS are measured on a 5-point likert-scale where 1 represents "not at all anxious"; 2, "a little bit anxious"; 3, "moderately anxious"; 4, "very anxious"; and 5 means "extremely anxious".

Piloting

Derived Chemistry Anxiety Rating Scale (DCARS) was piloted in Dilla University, Ethiopia. Forty-third year chemistry students were involved in piloting. Reliability check was made after piloting. Pilot data of DCARS indicated that learning Chemistry Anxiety Subscale, Chemistry Evaluation Subscale, and Handling Chemicals Subscale resulted in Cronbach Alpha coefficient of 0.97, 0.96, 0.94, and 0.93 respectively. These alpha values are excellent according to DeVellis (2017), which makes the tool reliable.

Subjects

DCARS was administered to 244 third year chemistry students which are senior level university students in Ethiopian context. Of these only 10 students data was discarded due to incomplete information. Only 234 completed the DCARS properly. Therefore, analysis was based on responses from 234 subjects (52 Female and 172 Male). All subjects were senior level (3rd year) chemistry students.

Analysis

For data analysis purpose, statistical analysis SPSS 28 version (online version provided for one-month trial by the company) was used. Means, Standard Deviation, Pearson product moment correlations and bar graphs were used to analyze the data collected.

Results

Collective comparison of anxiety subscale scores of undergraduate third year students

Table 1. Means, SD and rank for chemistry anxiety subscales

Subscale	N	Mean	SD	Rank
Learning Chemistry Anxiety	234	2.59	1.06	3
Chemistry Evaluation Anxiety	234	2.94	0.98	2
Handling Chemicals Anxiety	234	3.01	0.88	1
Average		**2.85**	**0.97**	

Table 1 displays the mean scores of university undergraduate students on three subscales of chemistry anxiety. The average or mean scores of the subscales Learning Chemistry Anxiety, Chemistry Evaluation Anxiety and Handling Chemicals Anxiety were 2.59 (SD=1.06), 2.94 (SD=0.98) and 3.01 (SD=0.88) respectively. The mean score of the subscales was 2.85 (SD=0.97), which indicates that the third year university students were moderately anxious in learning chemistry. This result showed that the third year chemistry students relatively high level of anxiety in Handling Chemicals Anxiety (Mean=3.01) followed by Chemistry Evaluation Anxiety (mean=2.94) and Learning Chemistry Anxiety (2.59). The result indicates that third year university chemistry students are relatively more anxious in handling chemicals though they are approaching their graduation in chemistry.

Anxiety levels of third year students in universities in terms of derived chemistry anxiety scale
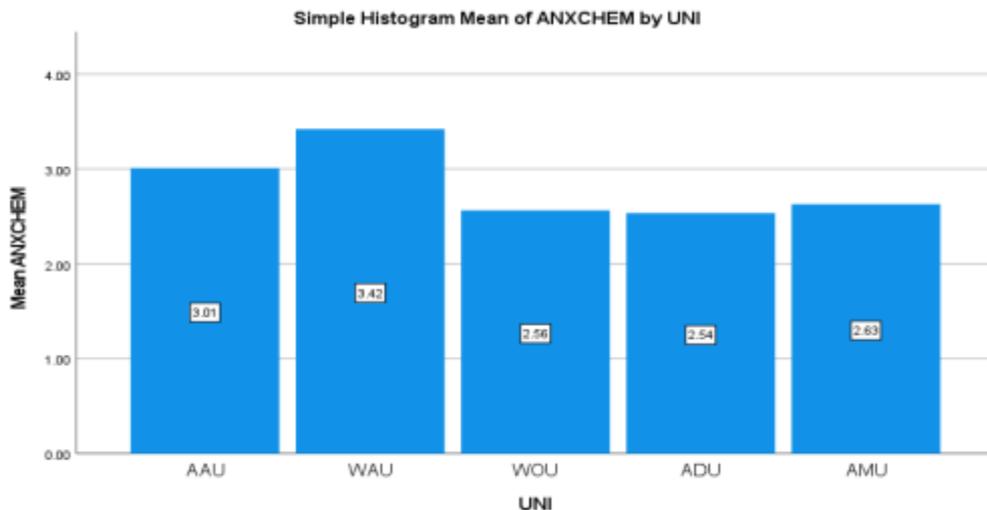
Figure 1. Universities (UNI) average/mean chemistry anxiety (ANXCHEM)

The bar graph above (Fig. 1) displays the mean scores of university undergraduate students on chemistry anxiety scale. The average or mean scores of Addis Ababa University (AAU) (N=26, Mean=3.01) and Wachemo University (WAU) (N=45, Mean=3.42) are in the range moderately to very anxious level of anxiety. slightly above moderate level anxiety. Moreover, the average or mean scores of Arbaminch University (AMU) (N=89, Mean=2.63), Wolaita Sodo University (WOU) (N=51, mean=2.56) and Adama Science and Technology University (ADU) (N=23, Mean=2.54) are in the range little bit to moderately anxious level of anxiety. Universities are not compared with others due to incomparable number of students in universities which participated in this study (ADU, N=23 third year students, AMU, N=89 third year students). Due to this simply the status of anxiety is reported in terms of the Derived Chemistry Anxiety Rating Scale (DCARS) levels.
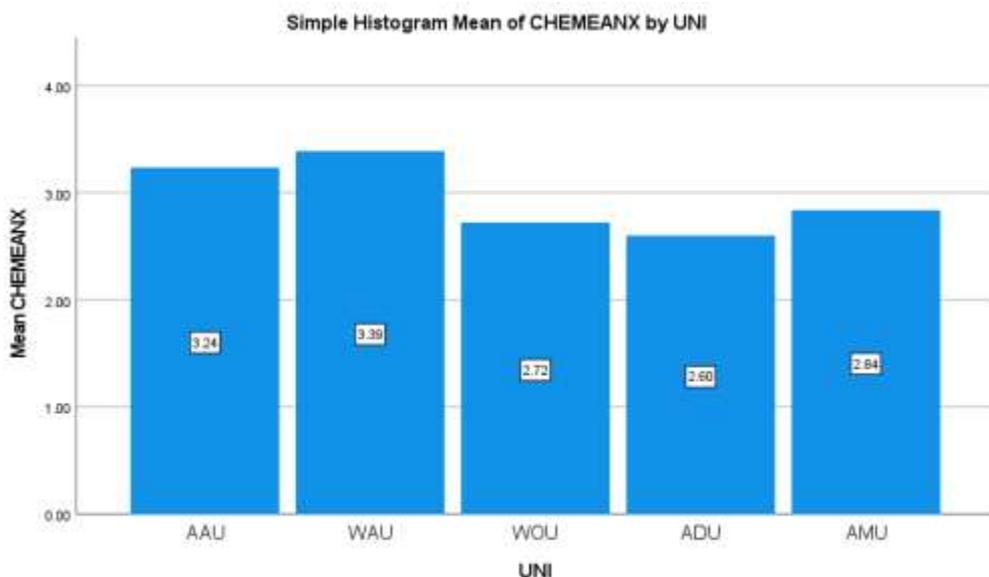
Anxiety levels of third year students in universities in terms of learning chemistry subscale
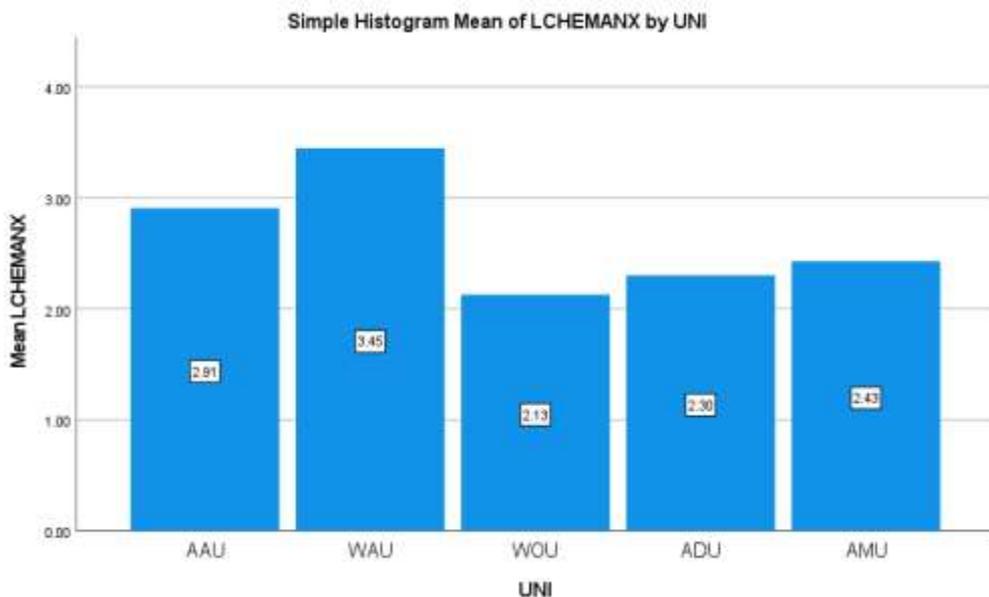
Figure 2. Average/mean chemistry learning anxiety (LCHEMANX) of universities

The bar graph above (Fig. 2) displays learning chemistry Anxiety mean-scores of university undergraduate students. The average or mean scores of WAU (N=45), AAU (N=26), AMU (N=89), WOU (N=51) and ADU (N=23) are 3.45, 2.91, 2.43, 2.13 and 2.30 respectively. WAU students are in the range moderately to very anxious level of anxiety. AAU, AMU, WOU and ADU are in the range little bit to moderately anxious level of anxiety. Universities are not compared with others due to incomparable number of students in universities which participated in this study (ADU, N=23 third year students, AMU, N=89 third year students). Due to this simply the status of anxiety in terms of learning chemistry is reported in terms of the DCARS levels in this part.

Simple Histogram Mean of CHEMEANX by UNI

Figure 3. Average/mean chemistry evaluation anxiety (CHEMEANX) of universities

The bar graph above (Fig. 3) displays chemistry Evaluation Anxiety mean scores of university undergraduate chemistry students. The average or mean scores of WAU (N=45), AAU (N=26), AMU (N=89), WOU (N=51) and ADU (N=23) are 3.39, 3.24, 2.84, 2.72 and 2.60 respectively. WAU and AAU university students are in the range moderately to very anxious level of anxiety. AMU, WOU and ADU are in the range little bit to moderately anxious level of anxiety. Universities are not compared with others in terms of this variable due to incomparable number of students in universities which participated in this study (ADU, N=23 third year students, AMU, N=89 third year students). Due to this simply the status of anxiety in terms of chemistry evaluation is reported in terms of the DCARS levels in this part.

Anxiety levels of third year students in universities in terms of handling chemicals subscale

Simple Histogram Mean of HCHEMANX by UNI
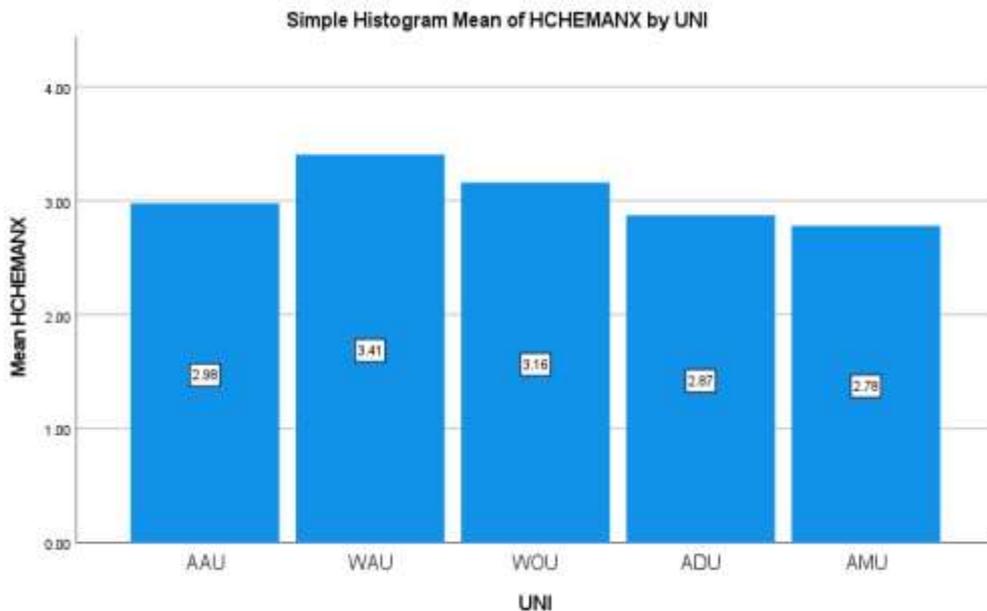
Figure 4. Average/mean handling chemicals anxiety (HCHEMANX) of universities

The bar graph above (Fig. 4) displays handling chemicals Anxiety (HCHEMANX) mean scores of university undergraduate chemistry students. The average or mean scores of WAU (N=45), AAU (N=26), AMU (N=89), WOU (N=51) and ADU (N=23) are 3.41, 2.98, 2.78, 3.16 and 2.87 respectively. WAU and WOU students are in the range moderately to very anxious level of anxiety in terms of handling chemicals anxiety. AAU, AMU and ADU are in the range little bit to moderately anxious level of anxiety in terms of handling chemicals anxiety. Universities are not compared with others due to incomparable number of students in universities which participated in this study (ADU, N=23 third year students, AMU, N=89 third year students). Due to this simply the status of anxiety in terms of handling chemicals is reported in terms of the DCARS levels in this part.

As indicated in the Table 2 below senior chemistry students in AAU and WAU are at moderate to very anxious level of anxiety in terms of DCARS/Chemistry anxiety. Moreover, senior chemistry students in WOU, AMU and ADU are at little bit to moderately anxious level of anxiety in terms of DCARS/Chemistry anxiety.

Table 2. Summarized table of anxiety levels of universities

Scale or subscales	Addis Ababa University	Woliata Sodo University	Wachamo University	Arba-minch University	Adama Science and Technology University
ANXCHEM/DCARS	MTVA	LBTMA	MTVA	LBTMA	LBTMA
LCHEMANX	LBTMA	LBTMA	MTVA	LBTMA	LBTMA
CHEMEANX	MTVA	LBTMA	MTVA	LBTMA	LBTMA
HCHEMANX	LBTMA	MTVA	MTVA	LBTMA	LBTMA

Note: Little bit to moderately anxious level of anxiety=LBTMA, Moderately to very anxious level of anxiety=MTVA, Learning Chemistry Anxiety =LCHEMANX, Chemistry Evaluation Anxiety =CHE-MEANX, Handling Chemicals Anxiety=HCHEMANX, Chemistry Anxiety/DCARS=ANXCHEM

The Table 2 indicates that senior chemistry students in WAU are at moderate to very anxious level of anxiety in terms of LCHEMANX/Learning Chemistry Anxiety. Moreover, senior chemistry students in AAU, WOU, AMU and ADU are at little bit to moderately anxious level of anxiety in terms of LCHEMANX. Besides, the table indicates that senior chemistry students in AAU and WAU are at moderate to very anxious level of anxiety in terms of CHEMEANX/Chemistry Evaluation Anxiety. Senior chemistry students in WOU, AMU and ADU are at little bit to moderately anxious level of anxiety in terms of CHEMEANX. Furthermore, the table indicates that senior chemistry students in WOU and WAU are at moderate to very anxious level of anxiety in terms of HCHEMANX/Handling Chemicals Anxiety. Senior chemistry students in AMU and ADU are at little bit to moderately anxious level of anxiety in terms of HCHEMANX.

A Pearson correlation coefficient (Table 3) was calculated to test the relationship between the undergraduate university chemistry students DCARS and Learning Chemistry Anxiety. From the output in the table, the correlation between DCARS and Learning Chemistry Anxiety scores for the undergraduate university students was r=0.947, P<0.01. Moreover, a Pearson correlation coefficient was calculated to test the relationship between the undergraduate university chemistry students DCARS and Chemistry Evaluation.

Relationships among DCARS and chemistry anxiety subscales

Table 3. Correlations among DCARS and anxiety subscales

Scale or subscale	DCARS	Learning Chemistry	Chemistry Evaluation	Handling Chemicals	M	SD	N
DCARS	1	.947**	.879**	.771**	2.79	0.88	**234**
Learning Chemistry		1	.769**	.582**	2.59	1.06	**234**
Chemistry Evaluation			1	.576**	2.94	0.98	**234**
Handling Chemicals				1	3.01	0.88	**234**

**. Correlation is significant at the 0.01 level (2-tailed).

From the output in the Table 4, the correlation between DCARS and Chemistry Evaluation scores for the undergraduate university students was r=0.879, P<0.01. Besides, a Pearson correlation coefficient was calculated to test the relationship between the undergraduate university chemistry students DCARS and Handling Chemicals. From the output in the table, the correlation between DCARS and Handling Chemicals scores for the undergraduate university students was r=0.771, P<0.01. A Pearson correlation coefficient was calculated to test the relationship between the undergraduate university chemistry

students Learning Chemistry and Chemistry Evaluation. From the output in the table, the correlation between Learning Chemistry and Chemistry Evaluation scores for the undergraduate university students was r=0.769, P<0.01.

A Pearson correlation coefficient was calculated to test the relationship between the undergraduate university chemistry students Learning Chemistry and Handling Chemicals. From the output in the table, the correlation between Learning Chemistry and Handling Chemicals scores for the undergraduate university students was r=0.582, P<0.01. A Pearson correlation coefficient was calculated to test the relationship between the undergraduate university chemistry students Chemistry Evaluation and Handling Chemicals. From the output in the table, the correlation between Chemistry Evaluation and Handling Chemicals scores for the undergraduate university students was r=0.576, P<0.01.

The correlations among DCARS and anxiety subscales were significant. Also, the correlations among anxiety subscales were significant. Both correlations indicate the university undergraduate chemistry students who rated high in DCARS also rated high on the anxiety subscale scores as the r values are positive. Also, correlations indicate the university undergraduate chemistry students who rated high in either anxiety subscale also rated high on the other anxiety subscale score as the r values are positive.

Discussion and conclusion

In this study, data showed that, university students' mean scores for Learning Chemistry Anxiety, Chemistry Evaluation Anxiety and Handling Chemicals Anxiety were 2.59, 2.94 and 3.01 respectively. The average score of students from five universities in the subscales was 2.85, which showed that the students are at 'a little bit to moderately' level. Nevertheless, 'moderate to high' level of anxiety was revealed by the university students in Handling Chemicals. The results of analyses revealed that the third year university chemistry students were a little bit to moderately anxious in Chemistry Anxiety (the whole scale) in three of the five universities; a little bit to moderately anxious in leaning

chemistry anxiety in four of the five universities; a little bit to moderately anxious in Chemistry Evaluation Anxiety in three of the five universities and a little bit to moderately anxious in Handling Chemicals Anxiety in three of the five universities. However, the students exhibited Moderately to very anxious level of anxiety in Chemistry Anxiety (the whole scale) in two of the five universities, Moderately to very anxious level of anxiety in learning chemistry Anxiety in one of the five universities, Moderately to very anxious level of anxiety in Chemistry Evaluation Anxiety in two of the five universities, and Moderately to very anxious level of anxiety in Handling Chemicals Anxiety in two of the five universities. The findings are consistent with the findings in other studies (Huey, 2013; Woldie, 2019). A bivariate correlation analysis with 2-tailed significance at p ≤ .05 resulted in significant correlation coefficients between DCARS/Chemistry anxiety scale and subscales. Correlations among DCARS and anxiety subscales were positive, indicating the university students who rated high in one anxiety subscale also rated high on the other anxiety subscale score. Correlation coefficient results are in harmony with the results of other similar study (Huey, 2013; Melaku et al., 2013; Woldie, 2019).

Though the study employed purposive sampling technique to select the five universities, the results indicate that chemistry anxiety exists in senior level university chemistry students. The study showed there are universities with 'little to moderate' level of chemistry anxiety. Also, there are universities with 'moderate to high' level of chemistry anxiety. The good news is that there is no university with 'high to very high' level of chemistry anxiety. The study showed that there is significant positive correlation among the scale and subscales. Analyses showed that the senior university students were more anxious on handling chemicals related anxiety (N=234, Mean=3.01). Anxiety affects students' performance. Thus university instructors are expected to teach chemistry by properly addressing the anxiety level of the students to make learners effective in their study area/chemistry.

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DETIVED CHEMISTRY ANXIETY RATING SCALES QUESTIONNAIRE

(Eddy, 2000)

Dear respondents, I am doing a study on university students' chemistry anxiety in relation to the title: Chemistry Anxiety of Senior University Students in Ethiopia: The Case of Five Universities. The data obtained from this Questionnaire will be used for academic purpose. Your honest answer to each item has meaning for my study. So, you are kindly requested to respond to all questions based on the instruction given. Your cooperation and contribution towards this research is crucial and very much appreciated. All information given will be kept confidential.

Thank you for your cooperation

Part-I: General information

1. Sex (Put √ mark): Male_____ Female _____

2. Age (write on the space): _____

3. Year (write here): _____

4. Department (write here): _____

Part-II: Anxiety towards chemistry (put √ mark or encircle each item response)

In order to better understand your anxiety level, please respond to each of the following statements from the perspective of anxiety levels provided here. Anxiety levels are measured on a 5-point scale where 1 represents "I am not at all anxious"; 2, "I am a little bit anxious"; 3, "I am moderately anxious"; 4, "I am very anxious"; and 5 means "I am extremely anxious".

As a science student,		I am				
		not at all anxious	a little bit anxious	Moderately anxious	very anxious	extremely anxious
1	While reading and interpreting graphs or charts that show the results of a chemistry experiment	1	2	3	4	5
2	While starting a new chapter in a chemistry book	1	2	3	4	5
3	While reading a formula in chemistry	1	2	3	4	5
4	While picking up a chemistry textbook to begin working on a homework assignment	1	2	3	4	5
5	While watching a teacher work a chemistry problem on the blackboard	1	2	3	4	5
6	While walking into a chemistry class	1	2	3	4	5
7	when told how to interpret chemical equations	1	2	3	4	5
8	While signing up for a chemistry course	1	2	3	4	5
9	While listening to a lecture on chemicals	1	2	3	4	5
10	While using the tables in a chemistry book	1	2	3	4	5

11	While looking through the pages in a chemistry text	1	2	3	4	5
12	While reading the word "chemistry"	1	2	3	4	5
13	While walking on campus and thinking about a chemistry course	1	2	3	4	5
14	While walking on campus and thinking about chemistry lab	1	2	3	4	5
15	To buy a chemistry textbook	1	2	3	4	5
16	While listening to another student explain a chemical reaction	1	2	3	4	5
17	While listening to a lecture in a chemistry class	1	2	3	4	5
18	While working on an abstract chemistry problem	1	2	3	4	5
19	While waiting to get a chemistry test returned in which you expected to do well	1	2	3	4	5
20	While taking a quiz in a chemistry class	1	2	3	4	5
21	While taking an examination in a chemistry course	1	2	3	4	5
22	While getting ready to study for a chemistry test	1	2	3	4	5
23	When given a homework assignment of	1	2	3	4	5

	many difficult problems which is due the next chemistry class meeting					
24	While solving a difficult problem on a chemistry test	1	2	3	4	5
25	While taking final examination in a chemistry course	1	2	3	4	5
26	When thinking about an upcoming chemistry test one day before	1	2	3	4	5
27	When a chemical Spills	1	2	3	4	5
28	While listening to another student describe an accident in the chemistry lab	1	2	3	4	5
29	when told how to handle the chemicals for the laboratory experiment	1	2	3	4	5
30	While working with acids in the lab	1	2	3	4	5
31	When getting chemicals on my hands during the experiment	1	2	3	4	5
32	While breathing the air in the chemistry laboratory	1	2	3	4	5
33	When working with a chemical whose identity I don't know	1	2	3	4	5

34	When mixing chemical reagents in the laboratory	1	2	3	4	5
35	While heating a chemical in the Bunsen Burner flame	1	2	3	4	5
36	While walking into a chemistry laboratory	1	2	3	4	5

✉ Dr. Woldie Belachew (corresponding author)
Addis Ababa University, P.O. Box 1176
Addis Ababa, Ethiopia
E-Mail: bewoldie@gmail.com