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Influence of Gender and Previous Background on Burundian University Students' Perceived Difficulties in the Study of Chemistry

François Nitereka [1,2,3,4], Judith Ndayizeye [3,4], Fred Awaah [5], Peter A. Okebukola [6], Juma Shabani [2], Claire Nineza [3,4], Ferdinand Ndikuryayo [3,4] and Innocent Ntwari [3,4]

[1] Corresponding author
[2] Doctoral School
[3] University of Burundi
[4] CURPAS (Centre Universitaire de Recherche et de Pédagogie Appliquées aux Sciences)
[5] University of Professional Studies – Accra, Ghana
[6] Lagos State University – Nigeria

Abstract

The main purpose of this study was to identify difficulties encountered in understanding chemistry in the universities in Burundi. The study further examined the influence of gender and students' previous background in chemistry on their understanding of chemistry. The study used a sample of N = 817 students from 2 public universities and 2 private universities in Burundi. A survey was conducted to characterize the difficult concepts encountered by students in general chemistry. To achieve the study's objective, we used the mean analysis, frequency, percentage and Pearson correlation at a significance level of $\alpha = 0.05$. The results showed that among 23 concepts investigated, pH and octet rule are perceived as the most difficult concepts, with a percentage of 50.4% and 51.0%, respectively. The concept of acid was perceived as the least difficult, with a percentage of 17.3%. These findings were significantly linked to gender (p= .000) and concept difficulty, previous background (p= .000) and concept difficulty, and Lack of didactic material in the laboratory (p=.000) and concept difficulty. Appropriate remediating measures have been proferred to enhance students' understanding of chemistry.

Keywords: pH, octet rule, laboratory, teaching-learning, chemistry, higher education

1. Introduction

Many authors define difficult concepts as concepts that are not only difficult to teach but also difficult to learn by the students [1]. According to [2] and [3]understanding and using some concepts in chemistry is difficult for most of the students due to the abstract nature of chemistry. There are claims that when students do not understand the concepts well, they tend to run away from the questions asked during assessments, leading to poor performance in chemistry [4]. To improve student performance, many authors argue that there are factors related to either the student [5], the teacher [6], or the educational institution [7]. These factors could explain the difficulty of the concepts taught in science, especially general chemistry.

While different studies have been conducted in different regions in Africa to establish what constitutes difficulties in the study of some science and non-science subjects [8] [9] [10], in Burundi, there are no research efforts to investigate difficult concepts in the teaching and learning of chemistry, the factors associated with these difficulties, and the strategies that should be adopted to improve the teaching and learning of these concepts considered difficult in chemistry.
These deficits in the Burundian chemistry research space have necessitated this study to establish (i) the concepts perceived by Burundi university students as difficult and (ii) the influence of gender and students' previous background in chemistry on students understanding of concepts in chemistry.

2. Related Literature

Many researchers have focused on factors that have significant effects on student performance, especially in science subjects. Indeed, [6], [10], [11]have demonstrated the influence of gender among secondary school students and [12], [8] among students university. For example, [13] indicate that gender has an influence on the choice of section to attend.
In addition, [4] consider that laboratory experimentation promotes learning of difficult concepts, motivation, and development of appropriate scientific skills and attitudes in students. In order to master these difficult concepts, experimentation is necessary. According to [14], meaningful learning in the laboratory is possible when students have the opportunity to manipulate equipment and materials in order to construct their knowledge of phenomena and related scientific concepts.
About the didactic skills, [15] added that the qualification of teacher is considered essential by teaching professionals to be effective in pedagogical and didactic work.

3. Materials and methods

3.1. Sample and sampling technique

Four universities of Burundi were selected for this study, two public (Institut de Pédagogie Appliquée (IPA) and Ecole Normale Supérieure (ENS) and two private universities (Université des Grands Lacs (UGL) and Université de Ngozi (UNG).The criteria for selecting these schools was based on the universities teaching chemistry as a course for at least 10 years. Participants in this survey (N= 817) were first-year, second-year and third-year undergraduate students who had already studied general chemistry. A questionnaire containing twenty-three concepts considered to be difficult with a three-step Likert scale (very difficult coded 3, moderately difficult coded 2, not difficult coded 1) was adopted. The validity and reliability of the questionnaire is that, it has been previously used for a similar study in the area of public administration [8].

3.2. Data analysis method

IBM SPSS 23 was used to analyses the mean scores, percentages, Pearson correlation at a significance level $\alpha = 0.05$. Tables were used to interpret the results.

3.3. Ethical Considerations

Specific ethical concerns were applied to the current investigation. After getting permission from the administrative authority of each university surveyed, the students were assured of the confidentiality of their responses. Students were further given the option not to respond if they felt uncomfortable participating in the study.

4. Findings

4.1. Objective One: Ranking of difficult concepts in general chemistry

Table 1 (below) presents the first ten concepts ranked very difficult among the 23 concepts of the survey. The results indicate that out of the 817 respondents, 412 respondents representing 50.4% considered pH to be very difficult, 211 respondents representing 25.8% perceived it to be moderately difficult while 194 respondents representing 23.8% considered the study of pH not difficult. This implies that most respondents (50.4%) found the study of pH to be a very difficult concept.

Also, on the study of Octet rule, 417 students representing 51.0% perceived it as very difficult, 183 respondents representing 22.4% considered it as moderately difficult, while 217 students representing 26.6% viewed it as not very difficult. This implies that the majority of respondents (51.0%) perceived the study of Octet rule as very difficult.

Table 1: Level of difficulty in the study of general chemistry in Burundian universities

Difficult concepts	Scale	Frequency	Pourcentage (%)	Mean rank
pH	Very difficulty	412	50.4	1st
	Moderately difficult	211	25.8	
	Not difficulty	194	23.7	
	Total	817	100.0	
Octet rule	Very difficulty	417	51.0	
	Moderately difficult	183	22.4	2nd
	Not difficulty	217	26.6	
	Total	817	100.0	
Quantum number	Very difficulty	377	46.1	
	Moderately difficult	244	29.9	3rd
	Not difficulty	196	24.0	
	Total	817	100.0	
Electronegativity	Very difficulty	315	38.6	
	Moderately difficult	272	33.3	4th
	Not difficulty	230	28.2	
	Total	817	100.0	
Oxidation number	Very difficulty	296	36.2	
	Moderately difficult	282	34.5	5th
	Not difficulty	239	29.3	
	Total	817	100.0	
Chemical equilibration	Very difficulty	288	35.3	
	Moderately difficult	280	34.3	6th
	Not difficulty	249	30.5	
	Total	817	100.0	
Electronic configuration	Very difficulty	310	37.9	
	Moderately difficult	213	26.1	7th
	Not difficulty	294	36.0	
	Total	817	100.0	
Chemical reaction	Very difficulty	251	30.7	
	Moderately difficult	319	39.0	8th
	Not difficulty	247	30.2	
	Total	817	100.0	
Concentration	Very difficulty	281	34.4	
	Moderately difficult	251	30.7	9th
	Not difficulty	285	34.9	
	Total	817	100.0	
Chemical equation	Very difficulty	254	31.1	
	Moderately difficult	302	37.0	10th
	Not difficulty	261	31.9	
	Total	817	100.0	

In addition, the concept Quantum number ranks third in the ranking of difficult concepts to study general chemistry. So, out of 817 students, 372 students representing 45.5% perceived it as very difficult, 244 students representing 29.9% perceived it as moderately difficult, while 201 students representing 24.6% considered it as not difficult. This indicates that the majority (45.5%) of the respondents perceived the study of Quantum number to be very difficult. Besides, the concepts Electronegativity and Oxidation number occupy the fourth and fifth places, respectively in the ranking of difficult concepts to the study of general chemistry. Three hundred and fifteen students representing 38.5% consider Electronegativity very difficult, 272 students representing 33.3% moderately difficult while 230 students representing 28.2% found it not difficult. On the other hand, 296 respondents representing 36.2% perceived Oxidation number as very difficult, 282 students representing 34.5% perceived it as moderately difficult, while 239 students representing 29.3% found it as not difficult. This implies that the majority (38.6 and 36.2%) of the respondents perceived the study of Electronegativity and Oxidation number to be very difficult, respectively.

As shown in table 1, 288 respondents representing 35.3% viewed Chemical Equilibrium as very difficult, 280 respondents representing 34.3% perceived it to be moderately difficult, while 249 respondents representing 30.4% considered the study of Chemical Equilibrium as not difficult.

In addition, the seventh concept is Electronic Configuration, where 310 respondents representing 37.9% viewed it as very difficult, 213 respondents representing 26.1%, perceived it as moderately difficult, while 294 respondents representing 36% considered it is as not difficult. Similarly, the Concentration study reveals that 281 respondents representing 34.4 % considered it very difficult, 251 students representing 30.7% perceived it as moderately difficult, and 285 students representing 34.9% found it not difficult. This implies that the majority (35.3%, 37.9% and 34.4%) of the respondents perceived the study of Chemical Equilibrium, Electronic configuration and Concentration concepts to be very difficult, respectively.

Further, table 1 showed that the Chemical equation is ranked tenth; in fact, 254 respondents representing 31.1% perceived it as very difficult, 302 respondents representing 37.0%, as moderately difficult, while 261 respondents representing 31.9% perceived the study of the Chemical equation as not difficult. This implies that the majority of respondents (37.0 %) perceived the study of the Chemical equation as moderately difficult.

4.2. Objective 2: Influence of gender, previous background and Lack of didactic material on difficult concepts

Table 2 (below) gives the Pearson correlation between variables (gender, previous background and Lack of didactic material) and perception of concepts' difficulty

		Concept Difficulty
Gender	Pearson Correlation	.182**
	Sig. (two-tailed)	.000
Previous background	Pearson Correlation	.300**
	Sig. (two-tailed)	.000
Lack of didactic material in the laboratory	Pearson Correlation	-.241**
	Sig. (two-tailed)	.000
	N = 817	

**. Correlation is significant at the .01 level (two-tailed)

- Pearson correlation on the relationship between gender and concept difficulty in the study of general chemistry among undergraduate students is equal to (r = .182, p-value = .000). This correlation coefficient reveals that the strength of the relationship is weak. The correlation coefficient further indicates a positive relationship between gender and concept difficulty. Although the relation between student's gender and concept difficulty is weak, the current findings implies that, there is relation between difficulties in the study of general chemistry and gender in universities of Burundi. This implies that a concept perceived as difficult for boys is also difficult for girls and vice versa.
- Pearson correlation on the relationship between secondary school background and concept difficulty in the study of General chemistry among undergraduate students is equal to (r =.300, p-value = .000**).** This implies that changing in previous background by students has a weak influence on the perception of the level of concepts difficulty. In addition, the p-value (.000 < .01) shows that the relationship between previous background and concept difficulty is highly statistically significant. This indicates that there is a great influence of the section studied in secondary school.
- Pearson correlation on the relationship between Lack of didactic material in the laboratory and concept difficulty in the study of general chemistry among Burundi undergraduate students is equal to (r = - .241; p-value = .000). The correlation coefficient of -.241 indicated a negative relationship between Lack of didactic material in the laboratory and concept difficulty. This implies that a change in Lack of didactic material in the laboratory translates into a decrease in concept difficulty in the study of General chemistry. This current finding indicates that the Lack of didactic material in the laboratory has a relation on student's difficulties in the study of general chemistry. Hence a student understanding of any concept in the study of general chemistry in Burundi public or private university will be positively influenced by the experimentation in laboratory.

5. Discussion of the findings

The first objective of the study was to establish the concepts in chemistry perceived by Burundian students as difficult. We found that, pH was the most difficult followed by octet rule, Quantum number, Electronegativity, Oxidation

number, Chemical equilibration, Electronic configuration, Chemical reaction, Concentration, Chemical equation, Chemical bond, Reductor, Oxidant, Chemical formula, Solution and Molecule in that order. The student, however, found the study of Molar Mass, Atom and Acid not difficult.

Our findings are consistent with previous studies. For instance [16] found that pH, electronegativity, enthalpy, entropy are examples of abstract and complex concepts that students often struggle with. [17] and [18] focused on oxidizing and reducing concepts while [19] studied acid-base reactions in the school curriculum.

We also found that, there is a statistically significant relationship between gender and concept difficulty in General chemistry with a p-value = .000. In addition, the science section is more frequented by boys (56.2 %) than girls (43.8 %), that is why our results show that gender influence positively the difficulty of the concepts in the study of general chemistry in Burundian universities.

Our results corroborate with those of other researchers [12],[13],[20]. However, [5], [4] stipulate that many students, especially female students, are afraid to study the science sections. This is amplified by the low number of students taking science in higher education institutions compared to literary and social science faculties.

Previous knowledge: During the evaluations, students want only to obtain points allowing them to advance from one class to another and especially to succeed in the state exams giving them access to the university; these students memorize the concepts taught in chemistry and automatically forget them in a short time. These students who didn't have the opportunity to master these concepts since high school advance to the higher grades with gaps.

In our study, out of 817 students surveyed, 117 students representing 14.3% didn't study sciences; however, they are studying Biology-Chemistry and Nursing sections at the university.

Furthermore with a p-value of .000 < .01 (table 2), our results clearly demonstrate that there is a statistically significant relationship between the section attended in secondary school and the perception of concepts difficulty during the teaching-learning of general chemistry by Burundian students. Several researchers said transitioning dynamics from secondary schools to the university have implications for effective learning of chemistry[21], [22].

Laboratory: Table 2 shows a significant relationship between Lack of didactic material in the laboratory and concept difficulty at p-value = .000 given the significance level of $p < 0.01$. Many researchers have already demonstrated that practical work in the laboratory done by students improves student performance[4] , [14].

Conclusion

In Burundi some secondary school teachers do not have the qualifications to teach this subject. For the sake of clarity, you will find only one teacher at the fundamental level who teaches biology, chemistry, physics, technology and even

geography and history. However, the teacher cannot be multi-skilled in all subjects to be taught. This may create a misunderstanding of key concepts related to each course which lowers the student's knowledge and consequently decreases their performance. I should recommend the course of chemistry must be taught at the secondary school level by experts (chemists) who have extensive knowledge in chemistry.

References

[1] I.O. Adekunle, Nuclear Chemistry as a Difficult Topic for Secondary School Students: Harnessing the Power of Indigenous (Cultural) Knowledge for its Understanding. In Okebukola P. A. (Ed.), Breaking Barriers to Learning: The Culturo-Techno-Contextual Approach (CTCA) (pp. 167-181), Slough, UK, and Delhi: Sterling, 2020

[2] R. Ben-Zvi. I.A. Hofstein and D. Samuel, The Attitude of High School Students towards the Use of Filmed Experiments, *Journal of Chemical Education*, **53** (1976), no. 9. https://doi.org/10.1021/ed053p575

[3] S. B. BouJaoude, A study of the nature of students' understandings about the concept of burning, *Journal of Research in Science Teaching*, **28** (8) (1991), 689–704. https://doi.org/10.1002/tea.3660280806

[4] O.C. Zudonu, C. Onisoman, Z. Chidubem, Effect of laboratory instructional methods on students' attitudes in some chemistry concepts at senior secondary school level, *Global Scientific Journals*, **6** (2018), issue 7.

[5] J. Adigun, J. Onihunwa, E. Irunokhai, Y. Sada, O. Adesina, Effect of Gender on Students' Academic Performance in Computer Studies in Secondary Schools in New Bussa, Borgu Local Government of Niger State, *Journal of Education and Practice*, **6** (2015), no. 33.

[6] F.A. Adesoji, S.M. Olatunbosun, Student, Teacher and School Environment Factors as Determinants of Achievement in Senior Secondary School Chemistry in Oyo State, Nigeria, *The Journal of International Social Research*, **1** (2008), no 2, 13−34.

[7] H. Azize, W.G. Robin, Best Practice of Individual Competences in Strategic Leadership among Principals of Excellent Secondary Schools, Malaysia, *International Journal of Scientific and Research Publications*, **5** (2015), Issue 6.

[8] F. Awaah, P.A Okebukola, A. Ebisin, D. Agbanimu, E.P. Oluwafunmilayo, O.A. Ajayi. Influence of gender and career interest on African university students'perceived difficult concepts in the study of public administration, *Teaching Public Administration*, **39** (2021), 1-19. https://doi.org/10.1177/0144739420968870

[9] O.A. Gbeleyi, F. Awaah, P.A. Okebukola, J. Shabani, O.C. Potokri, Influence of students' career interests on perceived difficult concept in computer studies in Ghanaian and Nigerian secondary schools, *Humanities and Social Sciences Communications*, **8** (2022). https://doi.org/10.1057/s41599-022-01215-3

[10] F.U. Onowugbeda, P.A. Okebukola, D.O. Agbanimu, O.A. Ajayi, I.O. Adekunle, F. Awaah, Can the culturo-techno-contextual approach (CTCA) promote students' meaningful learning of concepts in variation and evolution? *Research in Science and Technological Education*, 2022. https://doi.org/10.1080/02635143.2022.2084060

[11] F.A. Abuseji, Student and Teacher Related Variables as Determinants of Secondary School Students Academic Achievement in Chemistry, *Journal Pendidikan,* **32** (2007), 3-18.

[12] S. A. Adejimi, W. Nzabalirwa, W. A. Shivoga, Age, gender and verbal ability as predictors of students' achievement in Biology, *International Journal of Studies in Education and Science*, **1** (2020), no 1, 80-91.

[13] O.J. Jegede, and P.A. Okebukola, Differences in Sociocultural Environment Perceptions Associated with Gender in Science Classrooms, *Journal of Research in Science Teaching*, **29** (1992), no.7, 637-647. https://doi.org/10.1002/tea.3660290703

[14] A. Hofstein and R. Mamlok-Naaman, The laboratory in science education: the state of the art, *Chemistry Education Research and Practice*, **8** (2007), no 2, 105-107. https://doi.org/10.1039/b7rp90003a

[15] M. Liakopoulou. The Professional Competence of Teachers: Which qualities, attitudes, skills and knowledge contribute to a teacher's effectiveness? *International Journal of Humanities and Social Science,* **1** (2011), no 21.

[16] J. Quílez, A categorisation of the terminological sources of student difficulties when learning chemistry, *Studies in Science Education*, (2019). https://doi.org/10.1080/03057267.2019.1694792

[17] A. Basheer, M. Hugerat, K. Naji, H. Avi, The Effectiveness of Teachers' Use of Demonstrations for Enhancing Students' Understanding of and Attitudes to Learning the Oxidation-Reduction Concept, *Eurasia Journal of Mathematics Science and Technology Education*, **13** (3) (2017), 555-570. https://doi.org/10.12973/eurasia.2017.00632a

[18] S.H. Paik, K. Sungki, K. Kihyang, Suggestion of a Viewpoint Change for the Classification Criteria of Redox Reactions, *Journal of Chemical Education*, (2017). https://doi.org/10.1021/acs.jchemed.6b00593

[19] M.I. Machumu, Les modèles et la modélisation de la réaction acide-base dans le curriculum scolaire. Une contribution en didactique de la chimie dans l'enseignement secondaire supérieur en République Démocratique du Congo, *Thèse de doctorat*, 2011.

[20] M. F. Neathery, Elementary and secondary students' perceptions toward science and the correlation with gender, ethnicity, ability, grade, and science achievement, *Electronic Journal of Science Education*, **2** (1997).

[21] O.N. Mojisola, Interrogating the Teaching and Learning of Chemistry in Nigerian Private Universities: Matters Arising, *Journal of Education and Learning*, **10** (2021), no. 3, 132. https://doi.org/10.5539/jel.v10n3p132

[22] L. Edomwonyi-otu, A. Avaa, The challenge of effective teaching of chemistry: A case study, *Leonardo Electronic Journal of Practices and Technologies*, **10** (2011), no. 18, 1-8.

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