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Reasons Explaining the Difficulties of Understanding the Concepts in the Study of General Chemistry in Burundi Universities

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Abstract

This study was conducted to investigate reasons encountered in understanding concept in the study of general chemistry by undergraduate students in Burundi. Burundian University students were compared on (i) Teacher not leaving time for questions, (ii) no opportunity for group studies, (iii) syllabus wideness, and the using of a projector' as a reason for concept difficulty in the study of general chemistry. A Difficult Concepts in General Chemistry Questionnaire (DCGCQ) was administered to 817 undergraduate students to collect quantitative data for the study while a Difficult Concepts in General Chemistry Interview Guide (DCGCIG) was the qualitative instrument used to elicit responses from the 8 randomly selected participants from 2 public universities and 2 private universities. Among 23 concepts investigated, the results showed that pH and octet rule are perceived as the most difficult concepts in the study of chemistry. On the basis of chi-square test, a significant difference was noticed for concepts such as Octet rule, Electronegativity, Quantum number, Chemical equilibration,

Concentration, and Oxidation number. The reasons that cause difficulties in the study of general chemistry among the students of the universities in Burundi were largely attributed to group work, wideness of syllabi, and the use of projector in the teaching of general chemistry. Appropriate remediating measures have been suggested to ease the difficulties in the study of chemistry in Burundian universities.

Keywords: General chemistry, Concept difficulties, Burundian universities, teaching style, learning style

Introduction

Some concepts taught in chemistry are abstract and difficult to teach and learn [1]. [2] have recently shown that pH, Octet rule, Quantum number, Electronegativity, Oxidation number, Chemical equilibration, Electronic configuration and Chemical equation are perceived as difficult concepts in the study of general chemistry in the Burundian university system. Teachers and students respectively face difficulties when teaching or learning these concepts [3]. Teaching style [4 ; 5] and learning style [6 ;7] are two closely related reasons that may influence concepts difficulties.

A teaching style comprises the principles and methods used by teachers to enable student learning [8]. On the other hand, [5] defined learning style as the complex manner and conditions under which, learners most effectively perceive, process, store, and recall what they are attempting to learn. Authors have developed strategies facilitating teaching or learning in classroom over the years. [7] states that the teaching styles have evolved from the "blackboard and chalk" through the "whiteboard and board marker", "overhead projector and transparencies" to the nowadays most widespread data projector presentations. Many educational researchers seem to concur with the idea that, among other factors, the teacher's teaching style has some impact on student learning and the perceptions students develop about science learning and the work of scientist.

For the learning styles, according to [5] students learn well from visual stimulation such as seeing words in books or workbooks. [4] suggest some strategies that support active or cooperative learning such as the use of visual materials during lectures, slides, video and multi-media. Also, [6] demonstrates that students who prefer group learning style learn more easily in group interaction or class work. In contrast, students who prefer individual learning style learn best when they work alone, and they prefer to be self-readers.
According to [9] the syllabus usually represents the initial contact between the teachers, students, and administrators. First, teachers benefit from creating a syllabus built on scholarship because it helps them in planning classroom activities based on curricular, subject matter, and pedagogical knowledge. Second, students benefit from a syllabus built on scholarship because it has

the potential to organise, integrate, and direct learning. But its structure and contents play an important role in the understanding of the students. Third, for university administrators, a syllabus is at the center of program design and content covered.

Justification for this study

In previous scant studies in the field, [2] investigated 23 concepts in general chemistry in order to establish areas of difficulties from different perspectives. Among the objectives of this study were the classification of chemical concepts on the basis of their difficulty as perceived by students and the influence of gender and students' previous background in chemistry on students understanding of concepts in general chemistry. The present study aims to discover the reasons for which some concepts are judged difficult in the learning of general chemistry by undergraduate students from Burundi universities.

Specific objectives of the study

This research has four main specific objectives: (i) to establish whether there is a statistically significant difference between "teacher not leaving time for questions" and the concept difficulty in the study of general chemistry in Burundian university students; (ii) to found out whether there is a statistically significant difference between "no opportunity for group studies" and concept difficulty in the study of general chemistry in Burundian university students; (iii) to establish whether there is a statistically significant difference between "syllabus wideness" and concept difficulties in the study of general chemistry in Burundian university students; and to establish whether there is a statistically significant between the students' difficulty to follow the use of a projector and concept difficulty in the study of general chemistry in Burundian university students.

Literature review

[1] indicates that some concepts taught in chemistry are abstract and difficult to teach and learn. [2] state 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. Among those concepts figure redox reactions [10], oxidation-reduction [11],radioactivity, nuclear energy [12], pH, and octet rule [2]. Meanwhile, many authors demonstrate that chemistry is important in our everdaylife [3; 5; 8].

Data and method

Participants in this study were 817 students from two public and two private universities in Burundi. Students who participated in this survey were first-year, second-year and third-year undergraduate students and had already studied

general chemistry during the 2020-2021 academic year. The research technique used for data collection was a mixed-method approach that combines both quantitative and qualitative methods. Two instruments: the Difficult Concepts in General Chemistry Questionnaire (DCGCQ) and the Difficult Concepts in General Chemistry Interview Guide (DCGCIG) were developed. The DCGCQ, which was adopted from [13], was administered to 817 undergraduate students to collect quantitative data. In section A of DCGCQ, students indicated the level of difficulty at a three-point scale of very difficult (VD), moderately difficult (MD) and not difficult (ND). In a section B, the DCGCQ had a list of reasons for the difficulties and placed on a four-point rating scale of strongly disagree, disagree, agree and strongly agree. The DCGCIG was the qualitative instrument used to elicit responses from 8 randomly selected participants. [14] indicated mixed methods research is more able to answer certain complex research questions than qualitative or quantitative research in isolation.

Data analysis

Descriptive statistics and the chi-square test were used to cross-tabulate the data to meet the specific objectives. They were also used to determine whether or not there was a statistical difference between the variables tested. Quantitative data were summarized and pooled as tables in alignment with the specific objectives.

Ethical considerations

After getting permission from the administrative authority of each university surveyed, the respondents were assured of the confidentiality of their responses. The consent of the respondents was officially sought before the questionnaires were administered on them. The data gathered was exclusively used for academic purposes.

Findings and discussions

Among the 23 difficult concepts studied [2], the highest ten ranked concepts deemed difficult by students were selected in this study. The results of the analysis, applied at the 0.05 significance level, are presented in Tables 1, 2, 3 and 4.

The first specific objective aimed to establish whether there is a statistically significant difference between “teacher not having time for questions to the students” and concept difficulties in the study of General Chemistry by Burundian University students. Table 1 shown the results subject to chi square test.

Table 1: The teacher not having time for questions as a reason for the difficulty of understanding concepts in the study of general chemistry among Burundian university students

Concepts	Strongly disagreed				Disagreed				Agreed				Strongly agreed				
	ND	MD	VD	Total	ND	MD	VD	Total	ND	MD	VD	Total	ND	MD	VD	Total	Chi-square
pH	110	126	253	489	53	56	84	193	15	16	43	74	16	13	32	61	6.63
Octet rule	119	111	259	489	65	45	83	193	13	18	43	74	20	9	32	61	13.08*
Quantum number	129	139	221	489	37	65	91	193	19	21	34	74	16	19	26	61	4.65
Electronegativity	149	155	185	489	56	66	71	193	11	29	34	74	14	22	25	61	8.91
Oxidation number	152	168	169	489	48	68	77	193	23	21	30	74	16	25	20	61	5.35
Chemical equilibration	154	164	171	489	53	77	63	193	25	23	26	74	17	16	28	61	6.71
Electronic configuration	188	127	174	489	67	56	70	193	21	14	39	74	18	16	27	61	10.65
Chemical reaction	153	182	154	489	57	83	53	193	20	31	23	74	17	23	21	61	2.98
Concentration	165	150	174	489	71	69	53	193	29	19	26	74	20	13	28	61	10.07
Chemical equation	157	188	144	489	60	72	61	193	27	22	25	74	17	20	24	61	4.42

*Significant at less than 0.05

According to the result shown in table 1, out of the 817 students, 489 students representing 59.85 % strongly disagreed that "teacher not having time for questions to the students" is a reason for difficulty in understanding concept in the study of general chemistry by Burundian University students. Further, the result showed that 193 students representing 23.62 % disagreed that "teacher not having time for questions" is a reason for understanding concept difficulty in the study of general chemistry by Burundian University students. The results (table 1) reveal that, majority (83.47%) of the students disagreed that teacher does not give students time to ask questions on the concepts difficulty in the study of general chemistry.

Moreover, table 1 shows that statistically significant differences were not found in all the concepts observed ($p < 0.05$) except for octet rule. This implies that "teacher not leaving time for questions" in the study of general chemistry by Burundian University students does not significantly explain the difficulties in understanding concepts in the study of general chemistry by undergraduate students from Burundi.

When qualitatively interviewed, unnamed randomly selected students reported the ensuing.

Student 1, Institut de Pédagogie Appliquée: As the syllabus is too wide, the teacher tends to run fast in order to finish the course. When faced with difficult concepts such as pH, some teachers run away from the students' questions by

scolding them: "You only want to make me late because you have already seen it in the preceding classes".
Student 2, Institut de Pédagogie Appliquée: Even teachers allow us to ask questions, when confronted to a question about a difficult topic, some teachers evade those questions by answering we will see this concept later.
Student 3, Université des Grands Lacs: When faced with a difficult question, some teachers return the question to the class as an assignment. Unfortunately, even the next day the question will not be answered to the detriment of the students.

Our findings show that if the teacher scolds the students when teaching, they are afraid to ask questions. If students do not understand the subject, none of them dare not asking questions because of fear of being blamed by their teacher or their classmates. [15] states that, teacher may have a strong effect on students' qualitative achievement, learning behavior and personality building. **[6]**indicate that learning style is an important factor in several areas including students 'academic achievement, how students learn and teachers teach, and student-teacher interaction.

Table 2. No opportunity for group studies as a reason for the difficulty of understanding concepts in the study of general chemistry in Burundian University students

Concepts	Strongly disagreed				Disagreed				Agreed				Strongly agreed				
	ND	MD	VD	Total	ND	MD	VD	Total	ND	MD	VD	Total	ND	MD	VD	Total	Chi-square
pH	51	51	86	188	59	55	96	210	43	64	130	237	41	41	100	182	10.25
Octet rule	49	36	103	188	58	50	102	210	61	59	117	237	49	38	95	182	3.04
Quantum number	53	53	82	188	55	63	92	210	50	82	105	237	43	46	93	182	7.29
Electronegativity	74	53	61	188	67	73	70	210	49	93	95	237	40	53	89	182	30.18*
Oxidation number	61	67	60	188	62	76	72	210	71	79	87	237	45	60	77	182	5.49
Chemical equilibration	74	53	61	188	55	85	70	210	67	88	82	237	53	54	75	182	15.20*
Electronic configuration	80	36	72	188	71	62	77	210	78	73	86	237	65	42	75	182	11.01
Chemical reaction	68	64	56	188	53	94	63	210	74	94	69	237	52	67	63	182	11.13
Concentration	75	57	56	188	81	72	57	210	67	83	87	237	62	39	81	182	22.74*
Chemical equation	73	56	59	188	53	91	66	210	77	90	70	237	58	65	59	188	11.13

*Significant at less than 0.05

As observed from Table 2, the result obtained when verifying the second specific objective aiming at establishing whether there was a statistically significant difference between "no opportunity for group studies" and concept difficulty in the study of general chemistry by Burundian University students. The results indi-

cate that out of the 817 respondents, 237 students representing 29.01 % agreed that "no opportunity for group studies" is a reason for understanding concept difficulty in the study of general chemistry.
Further, 188 undergraduate students representing 22.28 % strongly agreed "no opportunity for group studies" is a reason for concept difficulty in the study of general chemistry by Burundian University students. This implies that majority (415 students representing 51.29 %) of the students agreed that students do not have the opportunity for group studies accounted for concept difficulty in the study of chemistry. Meanwhile, 48.71% of the students disagreed that student learn better in a group but does not have the opportunity accounted for concept difficulty in the study of chemistry. In addition, Table 2 revealed a statistically significant was found in only the concepts of Electronegativity, Chemical equilibration and Concentration ($p < 0.05$). This highlights that the absence of group study opportunities in the study of general chemistry in Burundian universities is significantly account for concept difficulties in the study of general chemistry among Burundian university students.

Unnamed randomly selected students qualitatively reported the following:
Student 4, Université de Ngozi: The majority of students are living outside the campus. After class, everyone goes home based in different areas, and there is no time to study together.
All students interrogated gave the same idea: Being together in the campus, there is no opportunity for us to study in group with others because all the time we have, is taken up with teachings; and after class, everyone goes home.
With respect to the second research objective, the results of this study revealed that the majorityof the students (415 students representing 51.29 %)agreed that student do not have the opportunity for group studies accounted for concept difficulty in the study of chemistry.
This result is reflective of the works of [4; 16] and [17] while the work of [13**]** contradict our finding.

[16] indicates that group studies promote active, deep, experiential, collaborative, and cooperative learning. Further, he reports that group work is an efficient way of dealing with the increased growth in student numbers in higher education, especially in regard to reducing time taken in assignment marking and allowing reduction in class time. Further, [18] said that the cooperative learning exists when students work together to achieve joint learning groups. Further, in working cooperatively, students realise that they are mutually responsible for each other's learning and have a stake in each other's success.
According to [4], working in groups of four to six students increase the students' learning while developing such social skills as decision-making, team work and team management. This result is also in line with [17]'s that the benefits of collaborative learning and student-centered learning in higher education are widely recognised in academic literature.

Collaborative learning can provide students with a peer group outside of class with whom they can discuss new concepts and assimilate new ideas. [7]indicates that students 'least preferred learning style is individual learning style.
Contradicting, [13] reports that difficult concepts in the study of public administration are not influenced by group or personalized learning.

Table 3. Syllabus wideness as a reason for the difficulty in understanding concepts in the study of general chemistry by Burundian University students

Concepts	Strongly disagreed				Disagreed				Agreed				Strongly agreed				
	ND	MD	VD	Total	ND	MD	VD	Total	ND	MD	VD	Total	ND	MD	VD	Total	Chi-square
pH	55	51	88	194	51	57	97	205	43	54	107	204	45	49	120	214	7.09
Octet rule	56	43	95	194	62	46	97	205	53	52	99	204	46	42	126	214	8.68
Quantum number	51	49	94	194	56	66	83	205	51	73	80	204	43	56	115	214	14.20*
Electronegativity	69	55	70	194	62	78	65	205	53	73	78	204	46	66	102	214	18.81*
Oxidation number	61	63	70	194	69	66	70	205	53	80	71	204	56	73	85	214	6.07*
Chemical equilibration	67	63	64	194	56	76	73	205	55	81	68	204	71	60	83	214	9.15
Electronic configuration	78	48	68	194	77	50	78	205	68	60	76	204	71	55	88	214	4.23
Chemical reaction	56	84	54	194	72	70	63	205	57	85	62	204	62	80	72	214	6.00
Concentration	72	61	61	194	80	63	62	205	69	61	74	204	64	65	84	214	6.14
Chemical equation	72	72	50	194	65	73	67	205	56	85	63	204	68	72	74	214	7.65

*Significant at less than 0.05

The third specific objective sought to establish whether there is a statistically significant difference between "syllabus wideness" and concept difficulty in the study of general chemistry by the undergraduate students in Burundi.
When Burundian undergraduate students were compared on "syllabus wideness" as a reason for concept difficulty in the study of general chemistry, students agreed that syllabus wideness is a reason for concept difficulty in the study of general chemistry (table 3). Out of the 817 students, 214 students representing 26.19 % strongly agreed that "syllabus wideness" is a reason for concept difficulty in the study of general chemistry. Further, the result showed that 204 students representing 24.97% agreed that "syllabus wideness" is a reason for concept difficulty in the study of general chemistry. The table reveals that, majority of the students (418 students representing 51.16%) agreed that the syllabus wideness accounted for concept difficulty in the study of chemistry. As seen in the Table 3, a statistically significant differences were found in the concepts Quantum number, Electronegativity and Oxidation number except the

reaming one ($p < 0.05$). This finding depicts syllabus wideness as one of the reasons for some concepts difficulty in the study of general chemistry.

When qualitatively interrogated, unnamed randomly selected students reported the ensuing:

Student 5, Ecole Normale Supérieure: If the syllabus is too wide, the teacher tries to skim it to achieve the course. And the students during the revision focus only on the exercises done in class believing that the teacher will only bring the same exercises during the evaluation. If he changes the questions, everyone fails because they haven't had time to read the hall syllabus.

Student 6, Université de Ngozi: *Yes, the syllabus becomes difficult for me to sort out the essential from the accessory and I cannot review well the course.*

Student 3, Université des Grands Lacs: If the syllabus is too wide, the students have no time to prepare their sessions and especially to master difficult concepts. However, if it is less voluminous, all students are interested to read it.

This finding supports the works of [13; 19; 20]. In the study of [13], when students were interviewed about syllabus wideness as a reason of concepts difficult to study in public administration, students from African universities answered that the topics are too many and complicated to keep in mind as it makes it difficult to understand the concepts.

Further, in the studies by [19], his finding reveals that a syllabus written in a friendly, rather than unfriendly, tone evoked perceptions of the instructor being more warm, more approachable, and more motivated to teach the course. This implies that the content and structure of the syllabus may affect its understanding by students.

According to the same author, syllabus does not only inform students about a course and its requirements, but creates a first impression about the instructor and his or her attitudes toward teaching. In addition, [20] added that the syllabus for teaching should be typically organised in a hierarchical sequence of courses, where individual topics that are part of a more extensive unified course can be taught with progressive teaching style which will ease the difficulty in comprehension throughout the course period. In the same line,[19] argued that a syllabus outline the plan for the course, set expectations for how students are to communicate with the faculty, how the covered topics fit into the larger curriculum, and how students will be expected to interact with the course material. [13] concluded by suggesting that curriculum should include clearly defined objectives and lofty but achievable goals and should possess the ability to promptly meet course needs, and to reduce students'anxiety. Further, [21] opined that syllabi should include specific, measurable course objectives that detail how students should develop in cognitive, affective, and/or psychomotor domains. Our findings show that students should not understand the syllabus in the ways expected by teachers.

Table 4. The use of projector as a reason for the difficulty in understanding concepts in the study of general chemistry Burundian University students

Concepts	Strongly disagreed				Disagreed				Agreed				Strongly agreed				
	ND	MD	VD	Total	ND	MD	VD	Total	ND	MD	VD	Total	ND	MD	VD	Total	Chi-square
pH	50	57	121	228	49	38	87	175	49	61	93	203	46	54	11	211	5.70
Octet rule	61	48	119	228	48	48	79	175	56	50	97	203	52	37	122	211	8.83
Quantum number	72	57	99	228	47	52	76	175	39	79	85	203	43	56	112	211	20.58*
Electronegativity	76	59	93	228	44	60	71	175	57	76	70	203	53	77	81	211	10.29
Oxidation number	68	74	86	228	52	64	59	175	57	79	67	203	62	65	84	211	4.38
Chemical equilibration	74	70	84	228	45	64	66	175	72	74	57	203	58	72	81	211	9.29
Electronic configuration	92	54	82	228	68	46	61	175	62	62	79	203	72	51	88	211	7.34
Chemical reaction	75	86	67	228	50	76	49	175	63	79	61	203	59	78	74	211	4.17
Concentration	81	72	75	228	68	57	50	175	65	70	68	203	71	52	88	211	10.31
Chemical equation	76	78	74	228	52	70	53	175	63	76	64	203	70	78	63	211	1.76

*Significant at less than 0.05

The fourth specific objective sought to establish whether there is a statistically significant difference between “the use of projector” and the concept difficulty in the study of general chemistry by Burundian University students.

The results from the table 4 indicate that, out of the 817 respondents, 211 students representing 25.8 % strongly agreed that “the use of projector is a reason for concept difficulty in the study of general chemistry by Burundian University students. Also, on the study of “the use of projector” as a reason for concept difficulty in the study of general chemistry, 203 students representing 24.8 % agreed it. This implies that the majority of respondents (50.6%) agreed that the use of projector accounted for concept difficulty in the study of general chemistry. Further, table 4 shows that statistically significant differences were not found in all the concepts except the quantum number ($p < 0.05$). This highlights that Burundian university students perceive some concepts in the study of general chemistry as difficult because of the use of projector.

Unnamed randomly selected students qualitatively reported the following:

Student 4, Université de Ngozi. The use of the projector helps us a lot if the teacher explains the slides clearly. However, if the teacher only reads them, it is of no use to the students. It would be good to write mathematical formulas such as pH on the blackboard during the demonstration.

Student 8, Université de Ngozi. The teacher tends to explain the slides very quickly without giving us a chance to ask questions. He wants to finish his lecture without worrying about the students' difficulties.

Student 1, Institut de Pédagogie Appliquée: Even the use of the projector is appreciated, in a crowded classroom the students who sit behind are at a disadvantage because they cannot see the slide images clearly.

This finding is reflective of the works of [22; 23] while the work of [13] contradict our finding.

According to [22], there is the necessity to use technology for teaching, because some science concepts are difficult to describe without technology. Teachers prefer the use of animations to demonstrate them. Further, they indicated that technology can transform the learning process from teacher-centered to learner-centered and enhances students 'understanding of science concepts. The work of [23] has clearly demonstrated that all teachers surveyed positively appreciate the use of slides to project with a projector.

Further, students indicated the system had a positive impact on both attention and understanding of the material. Furthermore, teachers should take note of frequently asked questions by students added that the teaching styles are the leading factors that shape and assure the success of a highly complex teaching-learning process. According to [8], teaching styles influence the character of the learners, learning environment, and overall execution of learning in a classroom. At the university lectures, [24] indicate that nowadays the most widespread teaching style is based on slides presentation using computer and data projector. They also added that data projectors brought a substantial loss of interactivity between students and teacher into the teaching process if compared to the previously used "blackboard and chalk" style.

Our results do not totally contradict the use of projectors when teaching; rather students complain about the speed of the teachers, the time given to each slide is too short. This does not allow students to read and understand the content of the slides easily. This implies that university teachers should not just read the slides to gain time and finish quickly the course without the students having understood especially the difficult concepts of general chemistry. Moreover, not being familiar with the digital world since high school, Burundian students encounter difficulties in following the slides of the projector when they arrive at the university.

Contradicting, in the study of [13], when African university students were compared on "difficulty to follow textbooks/slides" as a reason for concept difficulty in the study of public administration, most of these students disagreed that difficulty to follow textbooks/slides is a reason for concept difficulty in the study of public administration.

Conclusion

Based on the findings, this study showed that groupwork, wideness of syllabi and the use of projector are some of the reasons for concept difficulty to study chemistry. Actually, Burundi tends to delete student housing which makes the majority of students external. As Burundi has one public university, the govern-

ment should try to build cheaper residential areas around campuses to allow students to work together after classes. Teachers should summarize syllabi that are large and difficult for students to follow and understand. Burundian universities should encourage the updating of syllabi each year and not simply use old syllabi. This will make the content of the syllabus more affordable and ease for students to understand the subject. Further, the use of digital tools for teaching is highly encouraged. However in view of our results, it recommended to combine the use of projectors and sometimes blackboards to demonstrate formulas judged difficult such as pH. Moreover, teachers should take into consideration of frequently asked questions by students, this will give them an idea of the topics that students found difficult in the study of general chemistry.

Although groupwork is highly envied by Burundian students, since the majority of students come from poor families and most are external, managing external life is unfortunately difficult. Perhaps the government could build residential areas around the campus to facilitate student housing.

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