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Teaching and Learning of Chemistry: The Hybridity of Third Space Approach

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Abstract: *This article explored diversity and hybridity in the third space as a teaching resource. Students bring to the classroom or third space their diverse sociocultural issues, knowledge levels of chemistry, and socioeconomic status. Educators also bring to the third space their university knowledge and culture. Hence, a classroom or third space is a hybrid. The intersection of the students' activity systems and educators' activity systems created a third space. Activity systems are social practices that include the norms, values, divisions of labour, and community goals. The study intended to explore the negotiations by chemistry educators and first-year students in teaching-learning of acids-bases reactions. It is a topic that most students experience challenges from secondary school to graduate level. Acids-bases are one of the threshold concepts. Qualitative research was employed in the study. Data were collected through classroom observations. A thematic approach was employed to analyse data. Five chemistry educators and their classes were purposely sampled. Cultural-Historical Activity Theory (CHAT) was employed to unpack group dynamics in a Zambian university. Interactions in the learning spaces generated constraints, tensions, diversity, and affordances for both educators and students. The findings suggest that hybridity may be a resource in teaching acids-bases threshold concepts. Educators should understand students' knowledge and cultural diversities. Researchers can investigate how students' different acids-bases knowledge levels can promote success in chemistry.*

Keywords: Teaching and learning, Affordance, Constraint, Diversity, Hybridity, Third space.

1. Introduction

Chemistry is one of the cornerstones of science, technology, and industry that contributes to our existence, culture, and quality of life (Sadhul, Tensiana, Cahyani, Laka, Annisa, & Fahriyah, 2017). Studies have shown that, right from secondary school through graduate school, students have experienced difficulties understanding and applying acids-bases theories (Bretz & McClary, 2015). Researchers have documented student misconceptions concerning acids and bases (Pinarbasi, 2007 citing Zoller, 1999; Cross et al., 1986). However, research has shown that students come from diverse social-educational backgrounds and possess different prior chemistry knowledge levels. Cognitive, social, and cultural borders were apparent between students' and the educators' communities of practices (CoP) (Wenger, 2010) and in the activity systems (Engestrom, 1997). At the interaction of CoP and activity systems is the unfamiliar space, referred to as the third space where educators and students end up negotiating practice. The classroom or lecture hall is a third space where teaching-learning of threshold concepts (TCs) takes place. In the lecture hall, there are rules (which are part of the culture), resources, and roles that are dialectically related to each other and mediates the culture, structure, and agency of students and educators.

Third spaces show that learning contexts are hybrid. Hybrid spaces are not 'easy', 'quick' and never 'a completed project' (Klein, Taylor, Onore, Strom & Abrams, 2013, p. 28). Bhabha's concept of third space "relates to unresolved tensions of living 'between' cultures and countries while trying to understand what it means to survive, to produce, to labour and create, within a world-system whose major economic impulses and cultural investments are pointed to a direction away from your country or people" (1994, p. ix). In education, the third space considers students' experiences in classrooms in which dominant and marginalised communities and discourse co-exist (English, 2005; Luk-Fong, 2010; Selby, 2010 cited by Cuenca et al., 2011). Interactions in these learning spaces are bound to generate constraints, tensions, and diversity.

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Nevertheless, these tensions are a radical site of rupture, innovation, and change leading to learning (Newman, Griffin & Cole, 2009). An activity system is a basic concept of AT (Engestrom, 2001). Conflicts and diversity are catalysts for individual or collective learning and the larger activity system. The affordances and use of diversity, sharing expertise, and mediating learning were part of the practice community. In the learning communities or contexts, interaction and collaborative learning were means of productive learning. Classroom activities included the demonstration of acids-bases reactions by the educator and students, classroom discussions, and student-student interactions.

On the contrary, teachers may decide to recognise these transformations and use them to establish hybrid learning or may choose to discard them (Gonsalves, Seiler & Salter, 2011). The third space helped us in understanding the complexity of learning contexts and their transformative potential. The third space might be considered an expanded activity from activity theory perspectives (Engestrom, 2001). In the expanded activity, the objects of activity are extended, and the activity itself reorganised, resulting in new learning opportunities. The third space can also be viewed as zones of proximal development (Vygotsky, 1978) as well as liminal spaces (Meyer & Land, 2003). The liminal space is a space of transformation directly connected to emergent ideas, thoughts, attitudes, and concepts at higher-level cognitive states (Land, 2014). ZPDs and liminal spaces are also disharmonious and hybrid (Bhahba, 1994; Hall, 2002). Hybridity captures the struggle of transformation and differences in the learning contexts where cultural, socio-economical, and epistemologies collide. Hybridity exists at multiple levels in activity systems (Engestrom, 2001). These varied activity systems are formal (within the classroom) and informal (outside the classroom) of learning contexts.

There are three major threshold concepts in *acids-bases*: the *Arrhenius, Bronsted-Lowry,* and *Lewis concepts*. The key or threshold concepts are the transfer of electrons, ionic bonding, and atomic structure. Students need to master acids-bases chemistry from this dimension, after which students' progress to mastering weak acids and bases, acids and bases constants, finding of pH and pOH values, conjugate acids and bases, neutralisation, buffer solutions, and acids-bases chemical equilibrium, which are connecting ideas in the three definitions.

Teaching threshold concepts are fundamental to students' learning of chemistry, which also transforms the learning of chemistry, without which chemistry educators will not be able to teach students effectively. Threshold concepts (TCs) in chemistry are related to other topics in chemistry, as in other science disciplines, which the lecturer and students must learn and master. The understanding of the TCs and their connections influence the approach to teaching acids-bases. By focusing on student learning of TCs, educators (lecturers) can maximise teaching and learning and student achievement in the classroom (Meyer & Land, 2003). Educators are aware that acids-bases are taught in secondary schools and that students bring these concepts to higher education. Chemistry educators should therefore learn acids-bases as threshold concepts so that they can impart this knowledge to students. This study, therefore, explored the teaching and learning of *acids-bases* as threshold concepts by chemistry educators and students.

To understand the educators' teaching and students' learning experiences of threshold concepts of acids-bases through interactions within and outside the classroom, I investigated how participants mediated the constraints and affordances. Three research questions guided this study.

1. What challenges do first-year chemistry students experience in learning the threshold concepts of acids-bases reactions?
2. What challenges do educators experienced in teaching threshold concepts of acids-bases reactions to first-year students?
3. What are the causes of high failure and dropout rates in first-year chemistry, and how can they be ameliorated**?**

Considering the research questions, this study sought to achieve the following objectives: 1)To investigate challenges experienced by first-year students in learning threshold concepts of acids-bases reactions; 2) To explore challenges educators experienced in teaching threshold concepts of acids-bases chemistry to first-year students and how these challenges could be ameliorated; 3) To investigate the causes of high failure and dropout rates and how they could be ameliorated.

1.1 Threshold concepts

Meyer and Land (2003, p. 1) introduced threshold concepts (TCs) as basic ideas in certain disciplines, which are "conceptual gateways" or "portals" that lead to a previously inaccessible and initially "troublesome", way of thinking about something. Once the TCs are mastered, students may be transformed in understanding, interpreting, or thinking of the subject matter. Disciplinary TCs are portals to learning more complex concepts. They rely on the transformation of basic TCs that a student integrates into the conceptual structure. Disciplinary TCs are revealed consensually over time within the community of the discipline (Land, Meyer & Baillie, 2010) and have emerged as definable abstractions. They are concepts that are central to a discipline and serve as "targets of the questions, problems, and judgments" (Land et al., 2010, p. x). The awareness of TCs can guide educators in prioritising "what should be taught, how it should be taught and how it should be best assessed" (ibid, p. xi).

1.2 Liminal Space

Learning involves the occupation of a liminal space during the process of mastery of TCs. Liminal space is the "transition period between the moments in which students did not grasp a threshold concept and the moment of grasping the TC" (Timofte, 2015, p. 85). The liminal could be troublesome, confusing, and paralysed due to conflicts and configurations involved in constructing new meanings of complex concepts and identities. A liminal space is also where learners may oscillate between old and new understandings while training their minds to suspend belief. Through oscillations, students may experience desolation, confusion, frustrations, stress, and a state of intermediate knowledge which are followed by the clarity of entry into a community of practice (Batzli, Knight, Hartley, Maskiewicz, & Desy, 2016). Liminal space is a space of creativity as well as a place where people can get stuck temporarily (Cousin, 2008).

1.3 University Failure and Dropout Rates

The failure rate is one of the biggest problems in education among students. If 15% or more of the students are not able to pass a class, it has a high failure rate (Wullur, 2012). The failure rate is the gauge of student dropouts who fail to receive passing grades during the term/semester. Failure in class can result in some students dropping out of school. On the other hand, academic success is achievement based on course grades and grade point average. The failure rate is higher in general chemistry than in other introductory courses at Fort Lewis College, USA (Cooper & Pearson, 2012). Whereas, the dropout rate, according to Arce, Crespo, and Mignez-Alvarez (2015), refers to students who leave a programme, leave the university, change their studies, or leave for other higher institutions of learning. Similarly, Larsen, Sommersel, & Larsen, 2013) describe university dropout as when the student leaves the university study in which s/he is enrolled without graduating.

1.4 Community of Practice

The community of practice (CoP) locates "learning in the relationship between the person and the world, in which human beings are social persons in a social world" (Wenger, 2010, p. 1). A CoP, "from an analytical perspective, is the simplest social learning system" and "from the instrumental perspective, may be viewed as a learning partnership" (p. 1). Learning in social systems requires making decisions "about what matters, what counts about learning, about directions and priorities" (Wenger, 2010, p. 12). Learning partnerships "may be collaborative" and harmonious" but may also be "tempestuous and full of conflict" (p. 12).

1.5 Research on Acids-Bases Chemistry

In Turkey, Ültay and Calik (2015) employed concept tests as a cognitive measure, attitude or aptitude scales, and semi-structured interviews in a study that investigated the effects of different teaching designs, which were (1) the Relating-Experiencing-Applying-Cooperating-Transferring (REACT strategy), (2) 5Es learning model and (3) traditional (existing) instruction relevant to "acids and bases" subject, on pre-service science teachers' conceptions and attitudes towards chemistry and to compare them with each other. The REACT strategy is an output of teachers' observed experiences and is not based on theoretically designed issues (Ültay & Calik, 2011 cited in Ültay &

Calik, 2015). The 5Es learning model consists of the Engage-Explore-Explain-Elaborate-Evaluate stages. The model demands that students link their gained experiences with daily life, socio-scientific or science-technology-society issues (Kurnaz & Çalik, 2008 as cited in Ültay & Calik, 2015). The third strategy is the traditional approach which is laboratory work, "talk and chalk". The results revealed that REACT achieved slightly better retention of understanding of the acids-bases concepts due to connections to daily life. The intervention also might have influenced students' conception of acids-bases chemistry and seemed to stimulate the students' interest in the acids-bases reactions under investigation. This may indicate that teaching designs may not change hard-core alternative conceptions that tend to cause students to be closed-minded.

2. Theoretical Frameworks

Cultural-Historical Activity Theory (CHAT) is used as a theoretical framework "for understanding and explaining human activity" (Foot, 2014, p. 3). Activity Theory (AT) … is "a comprehensive model of the interrelated elements of an activity system. It provides philosophical frameworks that can facilitate the investigation, illumination, and description of a community of practice (Wenger, 2010) where people work together with shared histories of activity and discourses to achieve common goals" (Barnard, 2010, p. 26). CHAT is depicted by a triangular, dialectically related series of interactions (Engeström, 2001). First-generation AT is a dialectic relationship between the subject and society. The first-generation's conception started with Vygotsky and is characterised by the "mediated act" (Vygotsky, 1978). Vygotsky (1978) formulated mediational artefacts and genetics to investigate mental and cultural development to explain interaction. Individuals could be understood within their cultural means, and society could be understood within the agency of individuals who use and produce artefacts.

Activity Theory was subsequently developed into a second-generation activity theory by Leont'ev (1978). Leont'ev graphically expanded Vygotsky's model into a collective activity system. Leont'ev used the "primeval collective hunt" to demonstrate the distinction and complex relationships between individual actions and collectively (cited by Sannino, 2011). "The subject is the individual or group engaging in the social activity chosen for investigation", such as the "hunter collaborates with others using tools (spears, knives, bush-beaters, etc.) and symbols (spoken and non-verbal language) to mediate the joint venture, the object of which is the prey". The desired outcome "is the transformation of the prey to the killed beast" (Sannino, 2011, citing Leont'ev, 1978, p. 1999). The object of other subjects would be the dead animal who would use appropriate tools and symbols skin, clean and cook the animal. The intended outcome is to provide food for community members (Barnard, 2010, citing Leont'ev, 1978).

Third-generation, a more elaborate model of AT (Engeström, 2001 cited in Saninno, 2011) was formulated to transform discourse communities into speech communities of practice through expansive learning. Expansive learning does not rely on acquisition or participation but on learning something which is not yet there. "Third-generation activity theory developed conceptual tools to understand dialogue, multiple perspectives, and networks of interacting activity systems" (Engeström, 2001, p. 135). Engeström (2001) elaborated on the concept of boundary crossing in activity theory, for instance, the concept of the "third space" to account for events in classroom discourse.

3. Methodology

In this study, a qualitative research method was employed. In qualitative research, the researcher aims to acquire first-hand knowledge of the research setting. To gain an understanding of a setting is to maximise the advantage of personal insight, feelings, and life perspectives to understand social life (Neuman, 2014). Therefore, multiple case-study (action, case-study, and phenomenology) research methods were employed in this study. I used purposeful sampling techniques to identify the research context and research participants. Five (5) first-year chemistry educators agreed to participate. There were four male and one female chemistry educators. There were forty-seven (47) of the first-year chemistry students participants were grouped from "A" to "F". Educators of general chemistry and first-year chemistry students are the participants in this study. Data collection was done using classroom observations. Three lessons were observed in each class and video-recorded. Lesson observations were accompanied by a post-lesson conversation to confirm the interpretations of the observations. The post-lesson conversations were also video recorded. The researcher sat in each of the five (5) volunteered first-year educators' acids-bases reactions lessons. The videos captured interactions that would have missed by just writing fieldnotes. Thematic analysis was employed in analysing the data. Once the themes were identified, they were compared and contrasted with the emerging key ideas across the transcriptions to review the initial codes. Subthemes emerged but, in this article, I focus on classroom observation and educators' post-lesson conversations. Themes from each classroom were compared across the classrooms to develop the description of each theme (Smart & Marshall, 2012). Subthemes were defined and named as perspectives of educators. Quotes for the themes were taken as evidence from the transcriptions.

4. Research Findings

In this section, I report on the research findings from the educators' video-recorded lesson observations and post video-recorded lesson conversations. The themes were grouped into three categories related to educator's perspectives, the challenge in the teaching-learning of TCs of acids-bases chemistry, and adjusting teaching-learning to be successful in chemistry was generated.

4.1 Educators' Perspectives

Teaching was experienced differently by educators. Hence, their experiences in the third space are described individually and collectively.

4.1.1 Students' Participation

Educators are concerned about students' performance in chemistry. Students are not working hard, are not interactive with lecturers, and more knowledgeable than others. In addition, educators claim that" successful students are serious, are keen and interested in the studies, and try to get clarification from the educators" where they experience challenges (Hamoonga & Inonge). Students acknowledged that they did not consult friends outside the classroom as Temwa stated: "As students, we do not socialise with others … look for the 'geniuses', socialise with them". Hence, failure to consult friends or lecturers is preparing to fail. It is their problem because struggling students are not interacting.

4.1.2 Students' Prior Knowledge

The community consisted of culturally diversified students from different schools, families, and provinces of Zambia, indicating students were at different chemistry knowledge levels. Students possessed ordinary level chemistry and majored in chemistry, physical science, combined science, advanced level chemistry, or second-year students repeating general chemistry. Students bring their diverse cultural, symbolic, and social capitals to the class, thereby creating a hybridised space (Hall, 2002). So, the classroom's cultural, symbolic, and social capitals are resources and could generate tensions. As a result, the hybridised nature of the classroom generates constraints and affordances for some students and educators. The teaching-learning of acids-bases reactions, therefore, requires collaboration between educators and students.

4.1.3 Connecting of Ideas

Acids-bases chemistry is connected to many chemical ideas in general chemistry such as atomic structure and periodicity, chemical bonding and molecular geometry, chemical equilibrium, reactions in solutions, stoichiometry, organic chemistry, and electrochemistry. It has a strong link to other topics in chemistry and even within acids-bases. Students' learning of acids-bases is a foundation of other topics. When students fail to master fundamental concepts they may experience challenges to learn other topics to come. Hence, when all topics are put together students may have a good understanding of chemistry.

4.1.4 Key Ideas in Acids-bases

Threshold concepts (key ideas) are like doors that open into another room. Key ideas are basic and core which someone should know to understand challenging concepts. Key concepts are at the centre of a particular topic or discipline, such as donating and receiving protons, donating, receiving lone pair electrons, and dissociating substances into hydrogen and hydroxide or oxide ions. Neutralisation, weak and strong acids-bases, buffer solutions, acid-base constants, and calculation of pH of acids-bases and buffer solutions are also key ideas. A student has to master acid-base from this dimension.

4.2 Challenges in Teaching TCs of Acids-Bases

A key challenge was the lack of hands-on-mind-on activities due to inadequate resources. Nevertheless, constraints created affordances for some educators, and affordances became a driving force of transformation in terms of teaching and learning. Educators modified their resources, roles, and rules to engage students collectively and individually in navigating learning (Engeström, 2001). Students were able to learn from each other, learn at their own pace, and work together to construct meaning within the lesson. Sharing knowledge and learning from each other promoted individual and collective successes. To overcome the lack of hands-on-mind-on activities, educators prepared problem-solving tasks in a handbook aimed at aiding students with their studies.

4.3 Adjusted Teaching

Educators who were aware of disciplinary TCs provided roadmaps to students on how to utilise TCs and integrate them across topics. They also prioritised what to "teach and how" they would "teach it" (Land et al., 2010). Educators are thinking of how to successfully teach the TCs of acids-bases and raise students' pass rate in chemistry. Within and outside the classroom are contexts of interaction, contention, and transformation between students' and educators' activity systems. Each educator adjusted his/her teaching differently to ameliorate the challenges in teaching. I present each educator's interaction in the third space.

Chanda, chemistry educator of group A., mediated and negotiated the activities by keeping eye contact with students, asking them questions, and waiting for their answers to sustain the interactions between students and lecturer. Chanda used students' answers to build on the knowledge, for instance, Chanda asked, "What is the effect of common ion? In what direction will this equilibrium change when you add a drop of hydrochloric acid"? Some students responded "to the right" while other students said, "to the left". Chanda then expanded on the responses of what happens when a hydrogen ion is introduced and causes the equilibrium to shift to the left, which is that molecules break up in ionisation. Chanda was also sensitive to students' reactions when he taught as they possess different levels of understanding and perceptions of concepts.

Hamoonga's group B lessons were a subject-centred environment. Upon realising that his students could learn, Hamoonga created an interactive classroom. He also exercised authority over the class. He demonstrated solving a problem on the board, and the students followed the procedure (Hoover, Giambatista, & Belkin, 2012). Hamoonga guided the students step-by-step to find the final and correct answer. He prepared a handbook of teaching notes and tasks for the general chemistry curriculum and often referred students to the handbook. Hamoonga expected students to study and to attempt to answer the tasks before coming to class. Only then were students able to talk to him, ask questions, and interact with him successfully, particularly using his notes, and he was able to mediate the students' challenges. These students would like to participate in the lessons, but the student-educator interaction seems to be curtailed by the lecturer's authoritativeness. Nevertheless, on many occasions, the educator code switched to vernacular on seeing that the students did not understand the acids-bases reactions, he gave an example, "If it was a sugar solution, the sugar concentration of 6.2 x 10-8 will be weak and 'unwa manzi' (Chinyanja, Zambian language)." Unwa manzi means drinking this concentration of sugar solution is equivalent to drinking water.

Zulu, a group D educator, noticed that some students were stuck at the chemical equilibrium stage and could not progress to acids-bases equilibrium level (ZPD) (Vygotsky, 1978). He adjusted the culture in the classroom to give the students more tasks and one-on-one interactions to master chemical equilibrium. He solved a few examples of problems with students on the chalkboard in a two-hour lecture. Inonge, the educator of group E, created study groups in which the "gifted ones" would explain challenging questions. Each group was given a question that one group member would explain before the class for fifteen minutes at the beginning of the lesson. Inonge employed a "think-pair-share" approach in teaching because she hoped that thinking in pairs would make it easier for them to interact with each other. Furthermore, she used virtual laboratory works. Ika's group F classroom context was student-centred. Within the context of the class, students, and educator shared power. In his classroom, students were solving problems with each other from the beginning of the lecture to the end, as he demonstrated on the board. As the activities progressed, the educator would pause to ask questions, and the students would also at some point ask questions.

5. Discussion of the Findings

Each class was large, mixed-gendered, and had between three hundred (300) and fifty (50) chemistry students. All activities were contextual within interdependent, interacting activity systems. Every activity theory has tools, rules and roles, and an objective. The objective of the educator is to teach TCs of acids-bases reactions so that students succeed in chemistry. The constraints and affordances highlighted the nature of mediation for students, which both the educator and students could engage in. The educator modified activities and the structure of the classroom to place students in a learning experience that requires a community of practice (Lave & Wenger, 1991).

Chanda engaged the students in the question-and-answer technique. He drew knowledge from his students and together constructed the correct meaning. He is a constructivist and a facilitator. Constructivists stress that learners are not passive recipients of knowledge but construct their meanings of concepts. The facilitator's task is to prepare the teaching material and establish the student-teacher and student-student relationships and an active learning context (Ültanir, 2012).

Hamoonga is an expert with skills and knowledge of chemistry. He insisted that students should study and do tasks that he has formulated before coming to class or ask questions. Despite students possessing academic capability, they are not experts. The students are newcomers to the university and chemistry. Hence, they are Legitimate Peripheral Participants (LPP) (Lave & Wenger, 1991). LPP is the process by which a newcomer works her/his way towards full participation. Hamoonga demonstrated solving problems step-by-step. Learners develop conceptual understanding by participating with experts in problems related to their real-world activities. At first, an LPP is challenged with less demanding tasks that are productive and necessary to achieve the goals of the community of practice. Hamoonga's authoritativeness showed that he possessed cultural capital and social capital which could generate symbolic violence for students (Bourdieu, 2011). Symbolic violence created constraints and possibilities. Contrary, his code-switching culturally linked to situational learning and created affordances to student learning. He may have reached about 90% of students as the language is easy to understand and students add sugar to their coffee or tea in their rooms.

Zulu to help students who were stuck at chemical equilibrium and could not progress to acids-bases equilibrium, did more examples in the textbooks and tutorial sheet. He adjusted the culture to solve examples of problems with students on the board in a two-hour lecture. Outside the classroom, Zulu gave the students more tasks and one-on-one interactions to master chemical equilibrium. This may depict the liminal/ZPD spaces in which a student enters on encountering conceptual challenges. The process of mastery of TCs requires one to enter a liminal space. Students are at various positions in the liminal. The process of constructing meaning by the student requires the provision of varied teaching and learning opportunities designed to meet students who may be at various stages within the liminal space. Vygotsky's (1978) Zone of Proximal Development (ZPD) posits that "any function in the child's cultural development appears twice, in two planes. First, it appears between people as inter-psychological category, and then within the child as an intra-psychological category" (Kozulin Gindis, Ageyev, & Miller, 2003, p. 1). Scaffolding (mediation) happens when an adult or an able peer of the learner assists the learner in overcoming a difficulty in learning what s/he was not able to learn on her/his own.

Inonge is a constructivist and a facilitator like Chanda. Collaborative learning that she promoted through group work and 'think-pair-share led to peer learning and co-generative dialogue. The activity was socially mediated by more able peers or more knowledgeable others (MKOs). Students in the liminal space or ZPD appeared to be constrained, but the constrained generated affordances by learning from peers. It allowed others to see that they were struggling, and their peers then came in to help through description and demonstration. Learning, therefore, became reciprocal activities (Boud, Cohen, & Sampson 2002).

In the group F activity system, power dimensions and roles were shared between students and educator. Ika redefined the rules of engagement and adjusted the distribution of labour between student-educator and student-student in the activity system (Bourdieu, 2011; Engeström, 2001). The educator collapsed the power dynamics of the traditional roles of teachers. Traditional roles regard the teacher as an authoritative and narrative figure and the students as passive recipients of knowledge (Feire, 2005). The adjusted structure empowered students to exercise agency to construct their meanings and transformed the oppressive traditional learning context (Freire, 2005; Kincheloe, 2008). The affordance created by the educator empowered the students to choose their strategies of learning, the pace of learning, and who they should engage in collaborative learning, which went beyond answering students' questions for clarifications. Both lecturer and students possessed cultural, social, and symbolic capitals (Bourdieu, 2011). However, the educator still maintained his position as a lecturer and directed the lecture.

6. Conclusions and Recommendations

The classroom context was chosen because it shows how educators interact with students and with the acids-bases chemistry, students' interactions with the educator and the curriculum, and students' interactions among themselves. Educators experienced challenges in teaching students possessing different levels of knowledge to get them all into the liminal space. Some required more time to grasp the concepts because students learned at their own pace. Additionally, students possess additional/alternative knowledge of Arrhenius, Bronsted-Lowry definitions, and some had not heard of Lewis's acids-bases definition before. To ameliorate these different knowledge levels of students and knowledge gaps, educators adjusted the roles, resources, culture, and rules of the classroom. Each educator adjusted his/her teaching according to their constraints and affordances. For example, Inonge encouraged students to form study groups in which students learn from each other. Other educators constructed tasks to study for each topic in general chemistry which students can work on in their private study time. During lessons, students worked in groups or pairs while the educators negotiated the learning with others. Educators were drawing on diverse resources which students brought to the classroom. The hybridity of the third space generated constraints and affordances and influenced the need for mediation Hence, hybridity could have been used as a teaching resource.

I propose that educators must find out the students' prior knowledge and understand that students possess diverse cultures, knowledge levels, and possibly alternative knowledge. Instead of building on the alternative knowledge, educators must go back and teach the basics of chemistry contents to bring students up to the university chemistry level. Study handbooks should include atomic structure, chemical bonding, chemical equations, and stoichiometry (basics), as well as the tasks for each topic for individual and collective study. Finally, researchers can investigate the impact of chemistry knowledge that students bring to the chemistry classroom.

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