



## STUDENT REFLECTIONS ON IMPLEMENTED CHEMISTRY EDUCATION CURRICULUM: AN EXPLORATION OF RELEVANCY

*Dilu Ram Parajuli\**, *Rishi Ram Subedi*

*Central Department of Education, TU, Kathmandu*  
*\*Corresponding author: dilu.parajuli@cded.tu.edu.np*

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### ABSTRACT

This article has been carried out to identify the reflection of M. Ed. completion students toward the chemistry education curriculum. The main objective of this study is to explore reflection and relevancy of the M.Ed. chemistry curriculum. Hence, it is focused on knowing M.Ed. pass students' reflections and responses to the chemistry education curriculum, exploring its relevancy, and collecting the key insights. It carried out in a mixed (quantitative and qualitative) parallel design. Seventy students (n=70) as sample for quantitative and seven students are chosen as participants for qualitative data from different batches (2014 -2020). For this inquiry; Likert's scale statement and open ended questionnaire are used as data collection tools. Specially, the Likert's scale is used to collect quantitative data and similarly, qualitative data by open ended questionnaire. The quantitative data were analyzed by SPSS 25 software based on the mean value and percentage. Similarly, qualitative data were analyzed by transcription, comparing, identifying themes, coding, and their elaboration and discussion process. And, its result was summarized in five main topics based on themes (curriculum content, organization, of content, pedagogical techniques and practices, evaluation techniques and practices etc.). To include all the ideas into the same pat, the chemistry education curriculum is the foundation of the chemistry/science teacher or teaching-related job, it has a huge ground of scope and it is very important to uplift the social, economic, and intellectual status of the nation hence we have to keep changing it the time relatively.

**Keywords:** curriculum, chemistry education, reflection, relevancy, transformative pedagogy

## INTRODUCTION

Science education is an important discipline in Nepal's higher education. If we look at the contribution in higher education, the contribution of Tribhuvan University (T.U.) seems to be the most. On the other hand, this university is trying to make its courses as timely as possible and has undergone dramatic changes related to the education reform of curriculum development and pedagogical improvement during the past few years. In the historical review of science and chemistry education, it seems that it passed different stages. In context of Nepal, the beginning of chemical education in Nepal may be traced back to 1921 when I.Sc. level of chemistry teaching took place in Trichandra College (T.C.) Kathmandu. Bachelor degree (B. Sc.) and Master's Degree (M.Sc.) level of chemistry teaching started in 1947 and 1965 respectively (Dhoubhadel, 2008). They are conducted under the T.U.

A long time (more than 35 years) the Central Department of Chemistry of Tribhuvan University has remained the only place for post graduate chemistry study place in Nepal with offering the courses in general chemistry (inorganic, organic and physical) as part I and specialized course in any of the three branches of chemistry as part II (Dhoubhadel, 2008). Similarly, Central Department of Education also offers master level courses in Chemistry Education in Nepal since 2001 (2057 B.S.). In the initial days of this course it was focused on pedagogical part of science and chemistry. Then, this subject has been going on continuously. While envisioning the curricular parts it is gradually balancing both content and pedagogical system. The last course of annual system course focused on content and pedagogy and semester system course (after 2014) is combination of content, pedagogy, and research as a "tripod".

In this context, this study tries to explore the student reflections at the Master's Degree in Education (M.Ed.) alongside the implemented curriculum of chemistry education at the Tribhuvan University (T.U.). The main working area of this study is going to focus on the relevance of chemistry curricula before being revised. Here, we noticed that the new or revised curriculum is implemented in the first semester (2021 batch) but this study collects the reflection of the course, just before this. Because the implemented curriculum passed a cycle of five years journey then it is very necessary to get the reflection and feedback of the students towards this course.

Moreover, planning, learning and effects of pedagogy are always underpinned by curricular work (Hopmann, 2023). The requirement of this curricular work and pedagogical activity are to prepare students for their career journey after graduation has long been a challenge for educators in higher science/chemistry education. Although students should also be able to apply their knowledge in new situations and show evidence of employability and life skills that are important to employer (Mello & Wattret, 2021). Hence, such kind of effectiveness of curriculum is identifying through various ways, however here we used graduates student's reflections to explore it. Because of within the Nepalese context of science/ chemistry education, so far no reflective practice-based research has been found or very little has been found hence we are developing this work to fulfill such kind of research gap in science/ chemistry education.

Like other fields, the word 'relevance' is currently present in many debates on chemistry education quite well and the question is arising what kind of curriculum is relevant? Why so many students do like/not like or learn/do not learn chemistry? They often perceive their chemistry lesson as being irrelevant to them. Hence, the term 'relevance' is not a clear theoretical construct and it has a broader meaning but in this research, we relate it with students' interests, professional needs, and personal or emotional needs. Larsen *et al.*, (2016) argued that reflection is not just for social purposes, it can also be used to "influence students' learning from experience, increase their awareness of their thoughts and actions, and increase their perceived recall of experiences" (p. 285). Furthermore, it is a key component of excellent (Bell *et al.*, 2010), and a beneficial process in improvement (Ferraro, 2000, para. 1). Theoretically, this inquiry process believed on the Dewey's theory of reflection (Dewey, 1991; Duffy, 2009). By having this type of reflective information, it helps to revise the alignment between program competencies and course learning outcomes, besides insemminates the different thought about the effectiveness of current pedagogical practices, assessment methods, and curriculum development process (Hilliger *et al.*, 2022).

## **METHODS AND MATERIALS**

This study is carried out on mixed design. To gain an in-depth understanding of the inquiry process this study was carried out using the QUAL -QUAN design (Morse, 2016) and encompassed a concurrent mixed methods approach. Because this study examines a broader range of research

questions to discover both themes (qualitative) and patterns (quantitative). Seventy students (n=70) are chosen as sample for quantitative data selected from different batches (2014 -2020) and they engaged with the implemented curriculum before the revision (5-years cycle). This sample size is chosen by using the sample size calculator (<https://www.calculator.net/>) at 95% confidence level and 50% population proportion. Similarly, Out of these seventy students, seven students were selected as participants of the qualitative research.

The data was collected from sample participants through a Likert scale (quantitative) and open-ended questionnaire (qualitative). We used the Likert scale as a reflection tool which is running from “strongly agree” to “agree,” “neutral,” “disagree”, and “strongly disagree.” These five positions were given simple weights of 5, 4, 3, 2, and 1 for scoring purposes. And it was developed including 23 reflective statements. These statements are covered both positive and negative statements. The Cronbach's alpha test has been done to verify the reliability of the quantitative tool. This test is conducted within themes-wise group, its value that is 0.764. It is acceptable. Similarly, the open-ended questionnaire was guided by student’s professional and personal needs-based guidelines.

The quantitative data were analyzed using SPSS Statistics 25, which yielded the mean, percentage, and standard deviation. Which offer a single numerical value that was utilized to characterize the whole Likert scale. The mean and percentage were used to examine and interpret the data. And all calculated values are categorized on positive response rate and negative response rate then analyzed the final perception of participant. The qualitative data were analyzed by using the following steps in data analysis: (1) transcription of data (2) emic to etic transcription by reading and re-reading the transcripts to surface the essence of the phenomenon (3) coding the data by segmenting, comparing, and labeling the text (4) identifying themes by comparing and grouping similar codes (5) elaboration of theme and discussion (Creswell, 2009). To finalize the analysis we merged the key information of quantitative and qualitative result as a form of discussion.

## **RESULT AND DISCUSSION**

### **Result of Participant’s Job Engagement**

Initially the data analyzed based on the participant’s job engagement. They are categorized into different professional sectors like teacher, civil

service, subject experts, other sectors (bank, financial sectors, NGO, INGO, etc.). The job engagement of the student was also satisfactory.

**Figure 1**

*Professional engagement of participants*

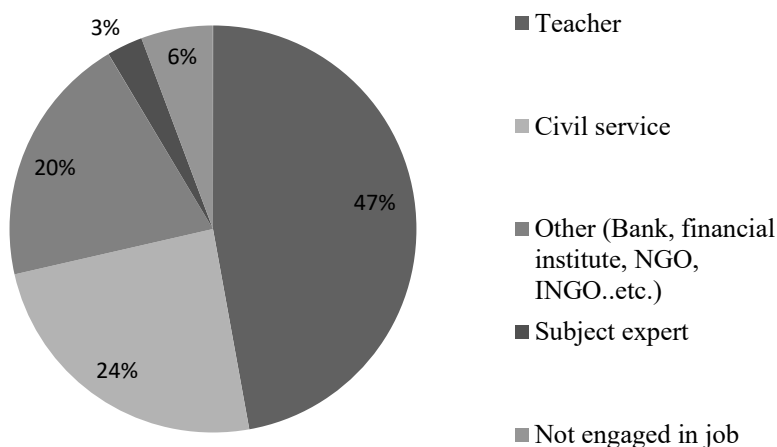


Figure 1 shows that 47% of participants are engaged as teachers, 24% of participants are engaging in civil service-related jobs, and 20% participants are engaging in other sectors (bank, financial organization, NGO, INGO, etc.), 6% of participants are not engaged in a job due to just passing M.Ed., and 3% in subject expert respectively. It means that most of the graduate of chemistry education are employed i.e. 94% of total students are employed. It represents very positive attitude towards this subject because the majority of the student's responses represented better engagement in the job after the completion of chemistry education.

### **Result of Reflection on Different Themes**

The result of the major quantitative data (Likert scale) indicated that the implemented chemistry curriculum was seen as satisfactory. Based on the participant's response, reflections are categorized into different themes. These themes are developed based on 23 statements which are includes

in Likert scale. The synopsis of analysis provided themes of statement presented below.

**Table 1**

*Summary of Descriptive Statistics of Different themes based on Likert Scale Statements*

Main Themes	Minimum	Maximum	Mean	Std. Deviation
Enjoying	4	5	4.14	.378
Usefulness	4	4	4.00	.000
Critical	2	4	3.71	.756
Daily life	2	4	3.29	.951
Best course	2	5	3.5	.976
Internal development	2	5	3.43	.976
Job engagement	1	5	3.43	1.272
Future orientation	3	5	3.71	.756
Professional support	2	5	3.86	1.069
Satisfaction	2	4	3.29	.951
Pre-prepare	2	5	3.43	1.272
Contextualize	2	4	3.71	.756
Carrier	1	5	3.14	1.215
Cognitive	2	5	3.57	.976
Activities	2	4	3.43	.787
Comparison	1	4	3.00	1.291
Feeling	4	5	4.57	.535
Needs	2	4	3.57	.787
Competencies	1	3	1.86	.690
Boring	1	3	2.00	.816
Pressure	1	4	2.57	.976
Suitability	1	5	2.86	1.574
Revision	1	4	3.29	1.113

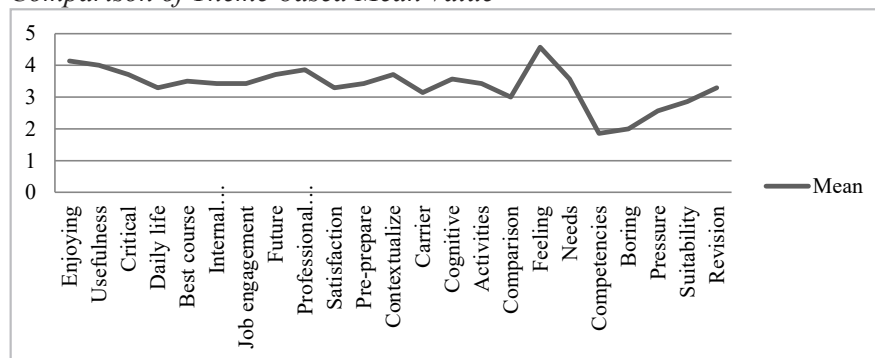
In the analysis of the mean value, the neutral rate (= 3) is the border value for the explanation of the statement. According to data, there are two types of data (mean values are generated greater than three (>3) and less than three (<3)). Both kinds (positive and negative) statements are explained based on this value. It means that rate or mean value “3” is taken for a neutral attitude.

**Themes with Mean Values Greater than Three (>3).** In the analysis of mean value >3 in table 1, most of the themes are below four. Like Enjoying (4.14), Usefulness (4.00), Critical (3.71), Daily life (3.29), Best course (3.5), Internal development (3.43), Job engagement (3.43), Future orientation (3.71), Professional support (3.86), Satisfaction (3.29), Pre-prepare (3.43), Contextualize (3.71), Carrier (3.14), Cognitive (3.57), Activities (3.43), Comparison (3.00), Feeling (4.57), Needs (3.57), and Revision (3.29). It means that somehow this course addressed the student's needs and interests but it was not sufficient. Because the mean value for revision is (3.29) or 57.1% of respondents suggested revision of this course. However, the strong part of this course was participants enjoying (4.14) with this course during learning and feeling (4.57) happy to completion. This is strongly supported by the responses of the “*I enjoyed with M.Ed. chemistry curriculum*” statement in which 85.7% of participants agree and 14.3% strongly agree. Similarly, the responses to the “*I am feeling happy after completing M.Ed. chemistry course*” statement also show that 42.9% of participants agree and 57.1% strongly agree.

**Themes with Mean Values Less than Three (<3).** In the analysis of mean value < 3 in table 1, two positive and two negative themes are rated mean value below 3. Both positive themes (competencies and suitability) have mean values are 1.86 and 2.58 respectively. It means that implemented curriculum did not develop expected competencies as well as the suitability for the context of science learning/ chemistry learning. On another side, the negative themes of boredom and mental pressures condition during learning are also below 3. Boring has to mean value of 2.00 and pressure has a mean value of 2.57. Comparison of mean value based on the neutral rate (=3) was presented below.

**Figure 2**

*Comparison of Theme-based Mean Value*



From the overall analysis of quantitative data, the mean value of majority of positive statements are seen as greater than three (>3) and negative statement are below three (< 3). It means that quantitative data supports the chemistry education course is satisfactory in student's perception.

### **Result of Qualitative Analysis**

Qualitative data was collected with the help of open-ended questionnaire among seven students who participated in the qualitative action. The analysis of the qualitative data and their result are summarized in five main topics. They are related to curriculum content, organization of content, pedagogical techniques and practices, evaluation techniques, and practices, and other. The main essence of this is as follows.

### **Content and Its Organization**

The curriculum needs to change. It was not cover all the knowledge which is necessary for master-level students. We should use the curriculum which is helpful for daily life and professional life. It has focused on theoretical concepts rather than practical but integrated forms be the best part of the curriculum like biochemistry, physical chemistry, natural product chemistry, etc. M.Ed. chemistry curriculum holds very useful and effective content although it fails to cover the content of analytical chemistry. Its content should be related to M.Sc. chemistry. And curriculum should help to bring change in people's daily life. Route learning is all enhanced by the current course.

Organization of content is satisfactory but not excellent. It further needs to make the excellent organization of content. The organization should focus on the science program. Need to be properly organized in some contents like as synthesis of nicotine terpenoids are new content and green chemistry is also needed for organization vertically as well as horizontally. The high-level concept of Natural Product Chemistry is included in the very first semester and it does not continue in further semesters. And, it lacks to set connection between the contents of all semesters.

### **Pedagogical Techniques and Practices**

Pedagogical techniques were mostly used in teacher-centered teaching approaches. Teachers only think about how to complete the subject matter. The teacher should be focused on the practical more than the theory.



In the way of pedagogical views, some topics are unclear in which approach to be used in the teaching process. Like synthesis of alkaloids, terpenoids, etc. The main target of chemistry education is to produce skillful manpower in the teaching field. So it's better to add ICT-based pedagogical techniques. Students-centered learning strategies should apply effectively. And it still lacks a student-centered approach. The use of only PowerPoint in teaching does not make it student-centered and effective.

### **Evaluation Techniques and Practices**

Most students think the internal evaluation system needs to change. The evaluation of the child is based on capacity, not on the three-hour exam (which is kindly used in our country Nepal). The evaluation technique is well but needs to properly use an internal assessment system for more relevance. The curriculum holds both s formative (internal exams, power point presentation) and summative evaluation (final exam) in a parallel way, which is very effective. However, sometimes it (internal examination) shows a halo- effect. It means the evaluation polices can be appreciated but lacks proper implementation.

### **Others**

Most of the students are suggested to change administration's working Style. Furthermore, they should be focused on more research-based content and address vertical organization of content for example green chemistry content needs to organize vertically. The evaluation system of the thesis portion should be modified and connect it more scientific and glocal scenarios. It needs some modification because in real-life chemistry education students are compared with pure chemistry students. The curriculum should be made in such a way that it can have its own worth.

### **Discussion**

Based on all the above information (quantitative data and qualitative information) and critical reflection three main findings are thematically (Barun *et al.* 2015) generated according to our research purpose. They are reflection of students, relevancy of curriculum, and fulfillment of need and interest of students.

### **Reflection of Students**

Chang (2019) arguments students' reflection plays crucial role in the field of science/ chemistry education. It has been used in different

perspectives for different purposes through the process of deep envisioning (Helyer, 2015). Hence the qualitative meaning making of this study tries supports Helyer,'s (2015) perspective. Furthermore, in the discussion, it took process of personalizing and understanding the contents, process, and the rationales for what learner have learned (Agouridas & Race, 2007) in chemistry education. It is related to chemistry content, teaching methods, projects, evaluation techniques, etc. it is the combination of all the chemistry content and pedagogical knowledge. Hence students must have had an overall good experience while studying this subject. They criticize M.Sc. chemistry curriculum is totally based on theoretical knowledge content so while in lack of teaching method student must have felt bored but M.Ed. chemistry included both content and pedagogical skills. They argued that compared to other subjects it is more practical than other subjects, in overall I had a good experience while learning chemistry education. Somehow this course fulfills student's needs and interests of students who are interested in being engaged in teacher, educator, and expert future.

### **Relevancy of Curriculum**

While we implement the curriculum it needs to ensure its relevance through based on authentic practical work and subjects are integrated with students' daily work experience (Hiim, 2017). In daily life activities and professional life this subject can prepare mostly be related to the teaching field, curriculum expert, and project about teaching chemistry. Students who have studied this subject are engaged in the educational field. The student whose main field of work is teaching so it must have been more relevant in its area. But rather than teaching fields, it seems that weak than other subjects. Participants claimed that *"It has both good and bad points. The good point about this curriculum is it provides opportunities to gain content knowledge, to analysis curriculum, instructional materials, questions item and which method to be used during teaching chemistry, evaluation techniques, and research knowledge, etc."*

It also provides practical space and how to use new technology or should teach how to adopt the technological change and learning theories in the teaching field. However, in our context mostly traditional teaching approach is adopted content is prioritized over ICT, modern technology-based content. It is unable to address the 21<sup>st</sup> century relevant to the current context but on our pedagogical side, it is satisfactory which a mean value

is 3.71. If this thing could be overcome than it has the scope to be relevant and effective.

### **Fulfillment of Need and Interest of Student**

The chemistry education curriculum has other important parts are teaching methods, approaches, and planning for chemistry learning. Participants' reflection supports the qualities of a chemistry teacher, objectives of science, management of chemistry class, and lesson plan. They talked this course fulfills students' needs and interests. And it must be address local needs and cover local scientific knowledge (Gurung & Parajuli, 2021). Also, statistically, the mean value of need is 3.57. Therefore, this course fulfilled the student's needs and interests of the student regarding current professional context of chemistry learning. It means that somehow this implemented curriculum act as a bridge between students' personal needs and the external environment (Liu *et al.*, 2022).

Based on above arguments we might be claimed that student's reflection after engagement and complete with the course will keep significant role to further improve all pedagogical aspect. It means reflection plays an important role in the field of science/ chemistry education for different purposes because reflection/critical reflection act as a golden-gate of transformative pedagogy and practice (Parajuli, 2023). Hence, this study allows students to reflect on their M.Ed. learning journey and provide references and suggestions for future practices as lenses of students' needs, interests, and relevancy to the real-world problems.

### **CONCLUSION**

The present era is the era of science and technology in which new knowledge of chemistry/science education is bursting out continually. But our chemistry education curriculum development process carried out an existing old pattern (expert-driven only not including stakeholders) and did not include the student neither the society or the nation because it could not address their needs and interest. And it also changed due to the increasing competition at the global level but our curricula are driven by the same old subject matters. Although, the practical/ laboratory works are limited to the lab only (not applicable in real life).

This study strongly emphasis on the reflective part of multiple spectrums (professional, vocational, relevancy, need, and other) of implemented curriculum (Fasari, 2022) integrating with contemporary

issues of science/ chemistry education. While, connecting this perspective with statistical value and qualitative reflection participant claims that the curriculum is made only from the perspective of subject scholars, and specialist. It cannot fulfill the needs and interests of student who come from various socio-cultural backgrounds return there. The related authorities responsible for curriculum development should conduct interaction programs with students and address their voices regarding curriculum development. And, it helps to create interactive model of curriculum development.

In conclusion, the overall analysis of this study shows that the chemistry education curriculum is the foundation of the teacher or teaching-related job, it has a huge ground of scope and it is very important to uplift the social, economic, and intellectual status of the nation. The reflection-centered science curriculum always focused on integration of theory and practice, competence and expertise (Horton *et al.*, 2012). Hence, due to the nature of course and connection with the profession, and a commitment to continuing professional development we have to keep changing it the time relatively in science/chemistry education courses.

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