International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-5 Issue-12, May 2016

Difficulties of Students from the Faculty of Sciences with Regard to Understanding the Concepts of Chemical Crystallography

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Abstract*—: *The origin of this work on the learning of chemical crystallography at university is the recurrent finding associated with the difficulty experienced by students, resulting in poor marks. The purpose of this study is to identify the difficult concepts in crystallography, to identify possible causes of these difficulties, and to offer remedies for this problem. For this we developed a three part questionnaire: the general capabilities of the student, the teaching conditions and the difficulties of students in terms of chemical crystallography. We undertook a survey of chemistry students in the Faculty of Sciences of Ben M'Sik Casablanca. After analyzing the data we found that the difficulties encountered in association with chemical crystallography may be due to several factors : the nature of the concept studied in terms of the difficulty of understanding, inadequate basic knowledge especially in geometry, the ability of low and middle level students with regard to the French language impedes their ability to follow the explanations of the teacher, curriculum overload, lack of concentration during the course and lack of motivation of students.

***Index Terms*— *chemical crystallography, learning, student's difficulties, teaching*.**

I. INTRODUCTION

Crystallography is the most powerful tool for studying the structure of matter, one thing is certain, crystallography, which has already led to applications in many areas is still far from having revealed all its potential . In the crystal, the atoms or molecules organize as a basic pattern that is repeated at regular intervals periodically as scientists say, which endows them with very specific properties. "Drugs, aerospace alloys, electronic components, materials geophysical ... The crystals are everywhere." Science devoted to them, crystallography allows to develop new materials for the structure and the increasingly complex properties.[1] Chemical crystallography enjoys the reputation of being the most difficult part of the chemistry program at the University.

Manuscript published on 30 May 2016.
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According to experts it is a subject that requires understanding of geometry and a conceptual training of the mind that requires a great deal of thought. chemical crystallography is not a popular subject among students and chemists at the University due to this perceived difficulty.

It is very common to hear students say "It's not chemistry." Indeed, the reasoning behind chemical crystallography is based on ideas of geometry and mathematics rather than chemistry, and yet, on the macroscopic physics and pure. Students, chemists, geologists and biologists in particular, face great difficulties to assimilate the basics of crystallography. These difficulties are due as much to the unpreparedness of these students to the complexity of the discipline itself.

The study of crystalline geometry requires good vision in three dimensional space and knowledge of various mathematical tools: elementary geometry, vector products, use of non-perpendicular axes, properties of polyhedra, tessellations of the plane and space, group structure, generating a group and relations between these generators,

The crystal geometry is simultaneously involves the point symmetry and the translational symmetry and, contrary to preconceived ideas, these two symmetries play very different roles (a space group is not the direct product of a point group by a group of translations reticular since any translation and rotation do not commute). Many new concepts should be introduced: network, single or multiple mesh, pattern, class, system, space group, site symmetry, reciprocal lattice, Miller indices, diffraction, Laue symmetry and Patterson, ...

The theory of space groups is confusing: the point symmetry elements of a crystal are not concurrent (unlike those of a molecule), periodicity may be greater than that of the crystal itself. enumeration methods crystalline groups, especially those groups of space, are too often ignored.

The nomenclature, conventions (choice of axes and meshes) and the ratings are complicated due to the existence of numerous individual cases.

Concrete examples usually given are often too simple (only one atom per cell) and incite confused nodes and reticular atoms while the network, whose origin is arbitrary, is purely mathematical.[2] The origin of this work on the learning of chemical crystallography at university is the recurrent finding of the difficulty experienced by students, resulting in poor marks. This study aims to investigate the difficult concepts in chemical crystallography and to identify possible causes of these difficulties, and to try to offer remedies for these difficulties.

II. RESEARCH METHODOLOGY

In this research we try to provide some answers to a number of questions based on the difficulties faced by students in the field of chemical crystallography. For this we developed a questionnaire consisting of 15 questions divided into three categories:

- The general capabilities of the student.
- The teaching conditions
- The difficulties of students in dealing with chemical crystallography

A. Population and sample

We conducted our survey with chemistry and physical students in the Faculty of Sciences Ben M'sik. The population consisted of two categories:

- Chemistry and physical students in the second year of the degree program who took the chemical crystallography part I course in S4 (141 students).
- Chemistry students in the final year of the degree program who took the the chemical crystallography part II course in S5 (58 students).

B. Interpretation of the results

After collecting the responses, the data have been examined and the frequency of each response category was calculated.

III. RESULTS AND DISCUSSION

A. General abilities of students

The capabilities of most S4 students range between "average" and "inadequate". This was deemed to be the ability to take notes (39.3%, 28.0%), to understand French (44%, 24.5%) to write in French (35%, 35%); and geometry reasoning ability (41.3%, 18.2%).

The characteristics of this sample show the very medium or low level of most students enrolling in the faculty. They enroll only when they have no other choice or wish to become science learning for the first time in French. This is consistent with the fact that some teachers' feel that the ability level of the students is the main cause of their learning difficulties. For students at the end of the cycle of license there is a slight improvement. Indeed we can say that most students range between "moderate" and "good" in terms of their ability to take notes (51.4%, 28.0%), understand French (48.0%, 40.1%) write in French (56.2%, 30.5%) and geometry reasoning ability (46%, 31%).

B. Teaching Conditions

A significant number of students (70% in S4 and 65% in S5) found that the contents of the courses were appropriate to their knowledge levels. 45.3% of S4 students found that there was no consistency in the lectures, tutorials and practicals whereas this percentage was 25% in S5.

The majority of students in S5 (81%) believe that there is consistency between the course and the evaluation of knowledge, while for S4 students this percentage was 51%. Overall we can say that the poor performance of students is not due to a lack of coherence between the course and control.

- State of infrastructure, instructional materials, staffing, use of time ...

This question sheds light on the conditions under which education is delivered and with regard to which potential problems should be solved. Unfortunately there was a high rate of non-response to these questions (about 25% in S4 and 16% in S5). One in three believe that the local conditions in terms of equipment, manpower and scheduling do not help provide a good education. Finally, most S4 students are not satisfied with the teaching methods (41% unsatisfied and 31% dissatisfied), while in terms of S5 students the dissatisfaction rate has declined but is still a source of worry (18% and 38% unsatisfied/dissatisfied).

IV. CONCLUSION

The student responses to the questions in this part reveal many very important points. These are as follows : Students (especially S5) argue that there is consistency in the lectures, tutorials and practicals and between courses and controls. On the other hand, one in three believes that the conditions (local, equipment, manpower and scheduling) are not conducive to good learning, and most students are not satisfied with the teaching methods used.

C. Students 'difficulties in chemical crystallography

S4 Students

64.5% of students at the end of the first cycle find the chemical crystallography studied in S4 to be difficult (rather difficult for 39% and very difficult for 18%).

The difficulties arise primarily from program overload (69% of students), the current methods of teaching (about 55%) and finally the problem of the teaching language (French), lack of exercise time and the complexity of the concepts (about 41%).

On the other hand, we asked students to classify some concepts in order of increasing difficulty numbering them from 1 to 11 (one for easiest, 11 for most difficult). After processing the questionnaires, we gave each concept a score in terms of difficulty (from 0 to number 1 to 10 for number 11) and calculated the total points for each concept. The result is presented in Table 1:

Table 1. points of difficulty for S4 students

Notion	Crystallographic geometry	Space group	Hexagonalsystem	coordination
Points of difficulty	284	280	212	190
Notion	Atomic coordinates	Density calculation	Unit-cells with three atoms	Structure projection
Points of difficulty	148	131	118	102

It follows from this ranking that crystallographic geometry and space groups are the most difficult concepts for students, followed by hexagonal system and coordination. These results match those found in the literature. 86% of S4 students experienced difficulties in chemical crystallography, and only 10% of students feel they have a good understanding of chemical crystallography.

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These difficulties relate primarily to the understanding of the course, the methods of working, understanding the directed works concepts, and finally the amount of work. The last item on the questionnaire was included to gauge the opinions of students with regard to means to improve their understanding of the concepts of chemical crystallography. The analysis shows that for students, reducing the course content and an increase in hourly directed works would contribute to an improvement in their level of understanding.

S5 Students

54% of students at the end of the cycle found that chemical crystallography studied in S5 is difficult (rather difficult for 38% and very difficult for 27%).

The difficulties arise primarily due to program overload (75% of respondents), the method of teaching and the lack of time for exercises (about 40%) and lastly the lack of prerequisites, the method of teaching in tutorials and complex concepts (about 42%). We note that French was no longer an obstacle for students. On the other hand, we asked students to classify some concepts in order of increasing difficulty by numbering them from 1 to 9 (1 for the easiest, 9 for the most difficult). After processing the questionnaires, we scored each concept in terms of difficulty (from 0 for number 1 to 8 for number 9) and calculated the total points for each concept.

The result is presented in Table 2:

Table 2. points of difficulty of S5 students

Notion	Crystallographic geometry	Patterson Fonctions groups	Friedel and Ewald relations Transformation	Laue and Bragg relations
Points of difficulty	325	296	242	192
Notion	Solid state solutions	Spinel structure	Perovskite structure atoms	Structure arrangement
Points of difficulty	188	154	141	118

It follows from this ranking that crystallographic geometry is always the most difficult concept for students, followed by Patterson fonctions and Friedel and Ewald relations. On the other hand, students found the concept of structure arrangement the easiest. In terms of causes, we might mention the fact that the concept of crystallographic geometry was already studied in the last semester (fourth semester), which supports the hypothesis that the program is overloaded and this constitutes the main reason for the difficulty encountered by students. 75% of S5 students experienced difficulties in dealing with chemical crystallography and only 9% of students feel they have a good level of understanding of chemical crystallography. This leads us to ask questions about how to overcome these difficulties. These difficulties relate primarily to the amount of work, the work methods, the understanding of the course and finally the understanding of statements in terms of the headings and corrections to the exercises.

The last item in the questionnaire was intended to gauge the opinions of students as a means of improving their understanding of the concepts of chemical crystallography. The analysis shows that for students, reducing the course content and increasing the diriged works TD and practical works TP contribution would lead to an improvement in their level of understanding.

V. CONCLUSION

The difficulties encountered in dealing with chemical crystallography may be due to several factors:

- The nature of the concept studied because his understanding is more or less difficult, Inadequate bases, especially in geometry.
- The low and middle level of the students in terms of their understanding of French impedes their ability to follow the explanations of the teacher.
- The curriculum overload.
- Lack of concentration during the course.
- Lack of motivation on the part of the students.

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