Information and Communication Technology and the improvement of knowledge: Case of the chemical thermodynamics

Azzedine Abbaci
Professor & Research Director
Centre de Télé-enseignement et Faculté des Sciences, Laboratoire de Synthèse et de Biocatalyse Organique, Université Badji Mokhtar, BP 12, Sidi-Amar, Annaba, Algérie
azzedine.abbaci@univ-annaba.org
Abstract

In this work we present an example of a chemical thermodynamics course conception that has been taught on a distance learning option and realized in a way to integrate the ICT (Information and communication technology) in the learning practices. Different steps have been followed in order to conceive pedagogical learning that are based on a realization of pedagogical choices involving learning activities set up according to technological choices and intended to learners. We have tested the impact of this on-line course on senior chemistry students of the chemistry department at the Badji Mokhtar University; the results of the first exam have been judged positively with respect to previous years.

Key words: Conception; chemical thermodynamics; devices.
Introduction

The e-learning has known a rapid growth within the educational establishments much as the development of information and communication technology has generated an important expansion and diffusion of knowledge. Thus, since the advent of Internet, the e-learning use of new technological means of information and communication and their associated learning activities as well as their evaluation tools, it has become more adapted to the rhythm of every learner (Perriault, 1996). Nowadays, taking into account of the learner personal requirements, constraints and specificity, different learning systems propose individualized learning environment to learners (Bensalah, 2006). Information and communication technology have promoted online training that can not be considered as a mere evolution of traditional systems of training, but rather as new mode of learning transmission accessible to everybody anytime and everywhere. These open e-learning options are after all of organizational in which learner can master his/her own educational path. This individualized path depends on the rhythm, acquired skills, availabilities as well as the learner experience (Bensalah, 2006). Hence, e-learning will permit the requirements needs of the professional and family demands and to take into account work and educational constraints. In this article we will expose conception steps of an online scientific course within the global framework of ICT at the higher educational level. To begin with, we describe our personal academic experience from our in the conception of a distance formation course applied to the area of chemical thermodynamics in terms of six steps (Abbaci, 2010, 2008). Then, we will present the outcome in terms of students performances in exams on a promotion composed of a final year curriculum chemistry group of twenty students in hybrid learning mode and compare the obtained results with a witness group belonging to the previous year with the same curriculum based on classical learning mode. Finally, we will draw conclusions about the comparison between the two learning modes from which we propose recommendation that we believe are essential for these kinds of situations. In order to develop an online course, it is recommended to pursue several key steps that are interdependent from each other. These steps are subsequently presented as follows (Abbaci, 2010, 2008; Essadidki & Jaillet, 2006; Elbaum & McIntyrec, 2002; George & Bothorel, 2006; Bender, Wood, & Vredevoog, 2004; Giardina & Oubenaissa, 2003; Landau, 2002):

- Step 1 : Problem analysis;
- Step 2 : Learning objectives formulation;
- Step 3 : Content structure;
- Step 4 : Learning scenario;
- Step 5 : Development;
- Step 6 : Test and validation.
Key steps of an online development

We have proposed several steps in order to develop and conceive a chemical thermodynamic course. During this procedure it was possible to go back to previous steps to make adjustments:

i- The first step consists of the problem analysis: We made a thorough analysis via a questionnaire that it exists a real need in the chemical thermodynamic formation for which distant learning activities could be an answer, then we describe the mobilizing idea behind that, insertion condition analysis, we also describe the public targeted by this development and identify the constraints and the outcome within which this course will be conceived.

ii- The second step concerns the course learning objectives formulation: in this step we outline the course learning objectives; these objectives are formulated in terms of the learner’s abilities to acquire new learning, i.e. capacity to accomplish tasks that will be acquired in terms of the formation activities and what the student will learn upon completion of the course. We can distinguish between two kinds of objectives; namely, the general objectives that encompass several abilities, and the specific objectives that refer to a single ability.

iii- The third step deals with the content structure: After having defined the learning objectives, we move on to the analysis and content structure of the learning activities. The aim of this step is to identify the knowledge to be attained and the necessary attitudes to attain the objectives. It must also establish the links susceptible to facilitate the knowledge acquisition and the abilities to be developed.

iv- The fourth step aims is the description of the learning scenario: Following the learning table of content establishment we proceeded to the description of the learning scenario related to this course intended to clarify every item such as definitions, examples as well as the auto-evaluation.

v- The fifth step aim is to develop the Website of the course: We have described the development of the course Website following the objectives definition as well as the learning activities, tables of content and the course elements.

vi- Finally, the sixth step deals with test and the validation: Once all the previous steps are achieved, we hired students in order to evaluate the site as well as the site content, the formation device. Improvement and adjustments have been made according to the content as well as to the formation device structure.

Methodology

An experimental study arrangement has been established with the students consent. Three chemical thermodynamic (classical) chapters have been chosen as themes of the experiment due
to their importance into the student’s curricula into the different university departments. We, therefore, have chosen hybrid learning with a predominant classical mode.

**Participants**

The number of the chosen participants is composed of twenty students belonging to the same class are registered at the chemistry department of the university Badji Mokhtar, Annaba, Algeria. All the students started their first university year by pursuing the technology option. Student’s ages and sexes as well as their previous experiences with ICT are presented in Table 1. However, we have notice that most of the students we have chosen have no experiences with ICT, therefore, our interest has focused on the asynchronous tool of communication, for this reason, we have invited the students to create their own electronic mails in order to receive their respective email by keeping in mind that within an e-learning context it is insufficient to materialize interactions between the students with such a communication tool and thus it is difficult to construct knowledge (George & Bothorel, 2006).

<table>
<thead>
<tr>
<th>Students Number</th>
<th>% Male</th>
<th>% Female</th>
<th>Scores</th>
<th>Students Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>45</td>
<td>55</td>
<td>Min.=18/20 Max.=06/20 Mean=9.72 SD=3.2</td>
<td></td>
</tr>
</tbody>
</table>

*: With previous training on ICT use

Table 2 Recapitulation of witness promotion characteristics

<table>
<thead>
<tr>
<th>Students Number</th>
<th>% Male</th>
<th>% Female</th>
<th>Scores</th>
<th>Students Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>40</td>
<td>60</td>
<td>Min.=18/20 Max.=02/20</td>
<td></td>
</tr>
</tbody>
</table>

*: With previous training on ICT use
Information and Communication Technology and the improvement of knowledge: Case of the chemical thermodynamics

Figure 1. Percentage Males/Females- a: This promotion, b: 2007/2008 promotion.

**Materials**

A CD-ROM containing the course Web Site and links to the three first chapter as well as exercises and MCQ as illustrated in figure 2 has been distributed to every student. It is important to notice that we have conceived the graphical interface of the course web site based on previous examples of schemes color conception that includes typographical, illustrations, navigation menu (Abbaci, 2010; Essadidki & JAILLET, 2006; Marcotte, 2011). The student’s recipient has been sent emails on commands on the course chapter to be handled, exercises to be solved. This procedure has been disseminated on the first semester of the year 2007/2008. The students have also been instructed to participate to class lecture or to tutored session. It is worth noticing that most of the material on the chapters is not found in the lecture, which means that a great part of the course content is only available on the course web site so as to encourage students to consult it. In the sequel, we give here the materials we used in this experiment as follows:

- **The course document**: Three chapters on the chemical thermodynamic course have been handled. They deal with: Mathematical tools interrelated to thermodynamics, such as the derivatives, and basic calculus, the three known principles of thermodynamics, and finally, some applications related to the thermodynamic functions, that lead to the famous Maxwell relations and the deduction of numerous thermodynamic properties of pure systems.

- **Exercises hand out**: Each hand out is composed of three to four exercises. These exercises correspond to the axes presented on the three chapters with the objective to control the student’s appropriation level on these three chapters. These handouts have to do with questions such as the mastering of the mathematical tools essential to the comprehension of thermodynamics; other questions have to do how to calculus and conversion of different thermodynamic quantities, other conceptual questions are asked. Examples of such questions on mastering mathematical tools
were: « In the first chapter on the mathematical tools, is how to distinguish between total exact and non exact differentials? » An example of conceptual question was: « What is the definition of the chemical potential? » An example of calculus and conversion of thermodynamic quantities was: « Use the Maxwell relations to calculate the entropy of a van der Waals equation of state».

- **Multiple choice questions**: Are given with directions to links with solutions that correspond to true answers in case of an unsuccessful trial.

- **On table exam**: Its aim is to evaluate the acquired materials during the first semester.

**Procedure**

Three steps were necessary for the experimental work to take place:

- The first steps has required only one session that was dedicated to questionnaire on data such as age, sex as well as the previous experiences with ICT especially on the frequency of mail use. This session was meant to explain the objectives of the utilization of ICT and the outcomes of the experiment itself. Twenty five minutes were enough to complete this session after which answers were returned.

- It is worth noticing that all these students have not taken a thermodynamic course during their third year, therefore, for the second step consisted of a one session pre-test which meant to test the background of these students in terms of thermodynamics. A period of one hour and a half was sufficient that purpose.

- The third step consisted of three sessions. These sessions were purely experimental ones. In the presence of a tutor, the students were given several exercises to solve while consulting the corresponding chapters. Each session has lasted approximately 30 minutes.
RESULTS

The analysis of the answers to the questionnaires on the questions concerning, the ages, sexes of the studied group and the witness group has not shown any large difference, however, it has shown a disparity in terms of experiences related to the previous use of ICT. We present the students performances the chemical thermodynamics first exam. Based on these preliminary results, we will present our recommendations to be adopted for the coming LMD sections in order to boost their performance in the future.

a. Data Analysis

Data are analyzed by SPSS program. Variance analysis (two-way) and correlation (Pearson) techniques were used to analyze data. Significance level is taken as 0.05.

b. Results and performance in the first exam

The total number of student belonging to the current promotion taken into this study amounted to 20. The individual scores performed by each student have been calculated on the basis of a scale of a maximum of 20 points reflecting the successful answers to the proposed questions. The minimum score obtained was 06 points, while the maximum was 18.5 points, with a mean value of 9.72 (SD, a standard Deviation=3.2), these figures are to be compared to the scores of the witness group belonging to the previous promotion totalizing a number of 20 students also, with a minimum score of 02 points and a maximum of 18 with a mean value of 7.62 (SD; a standard deviation of 6.06), where;

\[
SD = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \bar{X})^2}{N-1}}
\]

(1)

The term \(x_i\) represents the \(i^{th}\) student score while the term \(\bar{X}\) represents the mean value of the N scores. Tables, 1 and 2 give the mean scores of the two promotions.

A Pearson correlation factor of \(r=0.325\) was found and \(p\) value of the test has been found to be \(p=0.219\). This result shows that there is an average intensity or relationship between the two promotion vis-à-vis to their performances generated from the use of ICTE.

Conclusions and perspectives

Trough the results obtained in this article, we have shown that the communication tools can
be used to boost the performance of students in an educational context.

The obtained results of this study revealed that expected objectives by using of the new Information and communication technology have been attained. The statistical analysis of the collected data from the witness promotion has revealed a large dispersion of these data from the mean value (SD=6.06 as calculated from equation (Perriault, 1996)). Whereas, the scores of more than 76% of the students belonging to the studied promotion are only one standard deviation from the mean value, which represents in our view a clear improvement with respect to the witness group.

It is worth to mention that the type of tools used require a great constraints by users, however, it brings a much more freedom in the exchange structure between students. Only the use of all the communication tools will enable future promotion for the LMD sections (Licence-Master-Doctorate) to score much better results in their exams.

In this study, we have also shown the tremendous impact of the ICT utilization which can be measured by the added value generated. Therefore, in order to improve the current promotion as well as the future promotions we have to focus our attention on all the facilities offered by the ICT, such as starting on certain on-line learning activities offered by platform such as Univ-Rct platform of the University of Strasbourg that offers a great flexibility in the use of its functionality and which permits the presentation of an online course and the learning of small groups as well as the development of personal projects.

- **Acknowledgment**

  The author would like to thank l’Université Badji Mokhtar (LSBO), by the DGRST, PNR Contract N° 1/2011, avenant N° 88/2011, l'Université Louis Pasteur, l’Agence Universitaire de la Francophonie.
References


