

Computer-based Didactic Unit based on a simulator for the process of simple and fractioned distillation in the context of the education learning of Chemistry – UDQuim

J. C. Guevara Bolaños¹, A. García Martínez¹, C. S. Cruz Aguilar¹ y A. Sánchez Lozano¹

¹ METIS Research Group, Technologic School, Universidad Distrital, classroom 102 Block 1, Tr 70 B No 73 A – 35 South. Bogotá, Colombia

This article contains the general description of the Computer-based Didactic Unit based on a simulator for the process of simple and fractioned distillation in the context of the education learning of Chemistry - UDQuim developed from the work of the research group Metis, of Universidad Distrital Francisco José de Caldas.

Keywords: Problem solving; Computer-based Didactic Unit; simple distillation; fractioned distillation; didactics; constructivism; hypermedia; simulator; technological platform.

1. Introduction

The Computer-based Didactic Unit based on a simulator for the process of simple and fractioned distillation in the context of the education learning of Chemistry - (UDQuim), emerged from a research project that was aimed to improve the processes of education learning of chemistry and, more specifically, of the laboratory process of simple and fractioned distillation, which took place in the learning spaces of students of average education of the colleges and, in some cases, in university students.

Different aspects are included in this article: firstly, there is a description of the problematic situation in which the idea of the Computer-Based Didactic Unit emerged, the reasons that generated it and the approach) to a solution to solve the situation. Later there is a presentation of the Computer-Based Didactic Unit, describing the different components that conform it, the aims that were kept in mind, the environments and activities of learning which it relies on and the functions of support that it provides for both the teacher and the students.

Finally, there are some conclusions on the outcomes of the experience of the development and use form the students of the Computer-Based Didactic Unit.

2. Problematics

2.1. Description

In general, the students of chemistry face a problematic that affects not only the pupils in schools, but also those who deal with university studies. This problem lies in the process used to solve different types of problems (pencil-and-paper problems, practical problems, experimental problems), though the versions of both students and teachers regarding the failures mentioned previously are slightly counter-productive [1]:

- Lack of enough theoretical and procedural knowledge of application of the theory.
- Lack of strategies or ways of resolution.

- Incomprehension and overcharging of the terms of reference of the problem (these are out of context, unreal, with a deep theoretical interest, indiscriminate use of information).
- Lack of work from the pupils.
- Lack of mathematical calculation (in pupils).
- Limited domain of mathematical apparatus (in pupils).
- Limited domain of hypothetical- deductive thinking (in pupils)

It is possible to conclude that both teachers and pupils adduce the failures and their causes to external factors, without bearing in mind that the point of break could be located in the didactics in their current pedagogic model.

If we approach an important part of problem solving we observe a phenomenon that happens with frequency and not only in sciences: the pupils limit themselves to looking for general formulae to solve the problems, or they simply limit themselves to wait for the teacher to solve the problem. From this phenomenon, an almost unavoidable fact emerges, which is the mechanical problem solving, what leads to the lack of understanding on the process that is being observed. It also makes the pupil approach new problems in a systematic and monotonous way, creating slightly desirable habits in the pupil, in fields like the studies of science. Some missing factors in the current learning process of pupils are:

- Identification and definition of the problem.
- Diverse proposals of procedures.
- Data gathering and interpretation of results.
- Decision making.

The common didactic problem posing from textbooks comes to be a problem, as well, since they are structured in such a limited, rigid and lineal form that the pupil finally mechanizes the way of solving the exercises of the same type. This sort of exercises does not lead to the practice of essential aspects of the scientific methodology, which means that students have not learned to approach a real problem. Inside the problematic previously described, one of the most common laboratory procedures is involved: the simple distillation and the fractioned distillation, in which it is common to find these kinds of problems during their solution.

Additional, the design and development of educational software has great complexity since it is necessary to bear in mind the definition of the contents, the strategies of education of the contents and the kind of presentation adapted to facilitate the process of education learning [2]. Also, the educational design determines the type of interaction between the user and the program, as well as the form of didactic utilization. Nevertheless, in formal contexts of learning, the proper design can remain diluted by the type of method used by the teacher, which can cause the teachers to modify the perceptions of the product and accommodate it to their own practice [2] and [3].

2.2. Causes

Regarding the failures found in the problem solving during the laboratory practices of simple and fractioned distillation, there are some possible causes:

- Search of general formulae: This factor refers to the pupils in the moment of solving a pencil-and-paper problem; they appeal to using and memorizing general formulae that apply not only to the current problem, but to all the problems they cope with, restricting their capacity to think and approach real problems of different types.
- Pupils waiting for the teacher to solve the problem: When a pupil quits a problem he was not able to solve, he limits himself to waiting for the teacher to solve it, and it is when doubts regarding the teaching method used by the teacher emerge.

- Presentation of problems in textbooks: The main material of support for the students, the textbooks, have as a drawback the fact that they are plain, closed and rigid form, which means the problems presented in these books are all of the same type and non-editable so that, when the pupil faces a different sort of problem, he cannot approach it.
- Lack of a complete experiential situation: In this point it is outlined the lack of complete experimentation from the pupil for factors such as the geographical location, danger and management of some reagents, which make values and variables for pupils unlikely to be modified.

2.2. Solution

From the reasons previously mentioned, the design and development of an application that allowed, in the first instance, the opportunity for the student neither to depend nor to memorize formulae, emerged. This can be achieved if the program lets the pupil put into practice and exercise the theoretical knowledge acquired. As a second aspect, the software has to be able to offer the pupil the possibility of working in an autonomous way, that is, to experiment and practise when the teacher is absent; moreover, the application must count on a theoretical reference available to the student.

The software must have a hypermedia structure that encourages the pupil to explore; therefore it has to provide different types of problems which, at the same time, can be modified by the student.

Regarding the management of experiential situations, the educational material must provide the pupil a complete range of tools for the practice of simple and fractioned distillation. There are unmodifiable factors in a real laboratory (atmospheric pressure) and reagents that might be very dangerous in the moment of performing the practice; keeping this in mind, the educational material must allow the manipulation of these factors safely.

According to the previous analysis of the type of software that can be adapted to offer solution to these failures, it fits to a Computer-Based Didactic Unit consisting of a module that allows the teacher to supervise and evaluate the pupils in a personalized way, a theoretical referent complemented with a bank of problems to let the pupil experiment and put into practice the knowledge acquired thank to a simulator of simple and fractioned distillation for every case and, finally, a suitable space for the confrontation of ideas and exchange of knowledge, such as a Chat room.

3. UDQuim's description

3.1. Components

The Computer-Based Didactic Unit based on a simulator for the Process of simple and fractioned distillation in the context of the education learning of chemistry - UDQuim, is composed by six principal components: theoretical content, a bank of problems, a simulator, a Chat and a subsystem of supervision and evaluation.

The theoretical content stores a description of the principal concepts on distillation and the different necessary instruments to assemble the necessary structure to perform the process of simple and fractioned distillation.

The bank of problems allows the students to raise or formulate their problem, save it or select an existing one, before initiating their process of distillation, with the purpose being solved through the simulator.

The Chat allows different students and teachers to exchange opinions before, during and after the simulation of the process of simple and fractioned distillation.

The subsystem of supervision and evaluation, composed by a summary that allows to visualize the way as the student approaches the problem raised initially, could be used by the teacher to support the pupil's process of education and learning in the laboratory practice.

The simulator is composed by several stages, one where the student can provide all values corresponding to each of the necessary variables (as height and temperature) to perform a process of simple and fractioned distillation, another one stage where the student can carry out the assembly of the different necessary instruments to try a simple and fractioned distillation and the other one where it is possible to visualize the results of the process of distillation from the given values and the assembly.

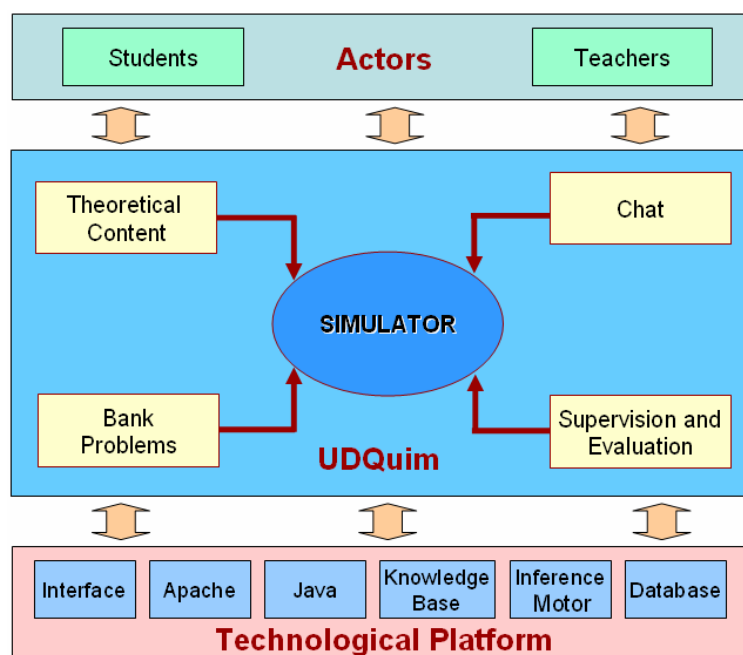


Fig.1. *Components UDQuim.* The graphic shows the different components conforms the Computer-Based Didactic Unit UDQuim.

The technological platform is formed by the different elements of software that support the functioning of the Computer-based Didactic Unit, like the interfaces done in PHP and JavaScript, the Web server Apache where there the interfaces and the applications are stored, the applications and the engine of inference developed in PHP and JavaScript, the data base that contains the set of rules that support the simulator stored in a file text and the problems and the information of users stored in a Posgresql data base.

3.2. Objectives

The design and development of the Computer-Based Didactic Unit has the following aims:

- To let the pupil face diverse problematic situations, to offer ,the student the opportunity to experience freely, allowing a better assimilation of the knowledge
- To offer the teacher a system that allows her to evaluate the pupil thanks to the contrast of a hypothesis, an approach and a result of the experimentation.
- To facilitate the interaction between the student and software in a virtual and teacher-guided way, that means, with the support of the teacher or without this one.

3.3. Environments and activities of learning

The environment of the Computer-Based Didactic Unit is based on a hypermedia structure, creating in the micro-world a open work setting where the student is the one who determines how he wants to build his knowledge based on his experiences, as well as he is free to choose his own sequence when exploring this micro-world.

Regarding the learning experiences in this software, it involves: an explorative dimension in which the theoretical framework is available for the student to examine; a section of contrast of ideas, in which learners share their doubts and achievements, reinforcing their knowledge throughout their process. Another activity available for learners is the problem bank where students obtain the problems to work on. It is important to note that this section can be enriched by the teacher. One of the most relevant activities is the simulator, where learners can put into practice their knowledge, formulate problems about the topic and provide the corresponding hypothesis, as well as contrast the results emerging from the simulator with their previous ideas.

Due to the fact that the Computer-Based Didactic Unit counts on components that catalogue it in the heuristic software, the system of evaluation will consist of visualizing the results of what the student her simulated; this lets the pupil analyse the contrast between the approach of the problem, the hypotheses and the results of the simulation; it is in this moment where the learner decides whether to examine the hypothesis or to change it to test it.

Additionally, the Computer-Based Didactic Unit contents a didactic model, the resolution of problems that allows to develop inside this the pattern pedagogic constructivism.

3.4. Functions of support to the teacher

By means of the interaction between the pupils and the educational software in real time, the teacher has the possibility to guide her pupils with different types of problematic situations, indicating them what problems to solve from the " Bank of Problems ".

Likewise, the quantity of exercises that the pupil has to solve can be given by the teacher, so that it is likely that learners increase their learning quantity and quantity, soon without the presence of their tutor. ince the system will register the process of the work of the pupil, as all the processes of simulation will be stored by the system, the teacher will have the possibility to obtain information about the work that her students have done.

The performance of the students by means of the interaction with the material can be obtained by the teacher, due to the fact that to that the results of every simulation done by the pupil will be stored.

The duration of every session will be determined by the teacher, in case the use of the software is done in her respective unit of class. The teacher will also be able to propose new approaches to every problems to simulate them and to add them to the Bank of Problems, hereby doing an evolutionary process enriching the approach of the problems proposed by or to her pupils.

Since the teacher can simulate also a problematic situation, she will be able to have both points of view of the process of education learning: as student and as a teacher.

3.5. Functions of support to the student

The software will have a Hyper-average structure for the pupil in case of being the first time that he interacts with the software, so that he does not have to learn routes or certain ways. It is not obligatory to cover a whole submodule to explore the other one: the submodules will be at free disposition so that the student explores them as many times as he wants.

In case the student works without being assisted by another person, the duration of the session will be determined by himself. The system will store the results of the simulations the student has done previously, consequently the student will have the possibility to examine them to bear his advances in mind.

The student receives the result of the simulation he las lately carried out; these result reports consist of the presentation of the problem he simulated, the suggested hypothesis, the discriminated variables and

the results given by the system. Through the contrast of all these factors, the student will be able to establish the reached achievements, to clarify several doubts, to suggest a new approach and in general to determine the level of authority of the topic he is dealing with. The student has an option of reinforcement whenever he tries to simulate a problematic situation. As soon as he executes the simulation, the results will inform him if the simulation took place normally or if, on the contrary, a mistake affected the process (The system will not tell the student what the problem was explicitly, it just indicates him that something happens, but it is the student himself who must detect the problem).

The student has the possibility to reach knowledge through discovery. With the material he will be able to have free access to the theoretical framework to get to know the topics on simple and fractioned distillation in deep, besides the possibility of relying on a Bank of Problems composed by problematic approaches suggested by the teachers, and finally, to exercise his knowledge, he will be able to practise experientially by means of a laboratory simulator where he can test a problem suggested by himself or one of the existing ones from the Bank of Problems.

4. Conclusions

Inside the educational materials developed previously related to the topic of distillation, there are failures in the pedagogic and / or didactic components, and many of these educational materials lack completely of some these two factors.

The union and teamwork of two or more groups of investigation generated results of major quality and more concrete, enriching the project from the line of investigation of every group.

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