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E-Chemistry, Next Step

Anca Madalina Dumitrescu[a], Ana Maria Josceanu[*a], Paula Postelnicescu[a], Raluca Daniela Isopescu[a], Valentin Plesu [a], Florina Ghindescu-Negura[b]

[a]University Politehnica of Bucharest, Centre for Technology Transfer in the Process Industries 1 Gheorghe Polizu Street, Building A, Room A056, District 1, RO-011061 Bucharest, Romania
[b]SIVECO Romania PLC, Victoria Park, 73-81 Bucuresti – Ploiesti Drive C4 Building, Sector 1, RO-013685 Bucharest Romania
a_josceanu@chim.upb.ro

The human resources project "Looking forward future – e-Chemistry" developed by the University Politehnica of Bucharest together with S.C. SIVECO Romania S.A. and the University Politehnica of Timisoara, was dedicated to introducing ICT tools to the K-12 chemistry teaching staff and to familiarization with teaching techniques based on dynamic and interactive multimedia electronic environments.
The feedback collected from 2,750 participants within e-Chemistry project pointed out the expectations of the participants and the degree in which they were fulfilled, the strong and weak points of the materials proposed in the frame of the project and suggested directions for content optimization, assuring the program sustainability.

1. Introduction

Our current education system is grounded on behaviourist and cognitive theories. Behaviourism, cognitivism, and constructivism are the three main learning theories most often used in the creation of instructional environments. However, these theories were developed at a time when learning was not impacted through technology. Over the last years, technology has reorganized how we live, how we communicate, and, subsequently, how we learn. Technology has been altering our brains. The tools we use define and shape our thinking (Siemens, 2012).
The three orientations mentioned above have serious shortfalls in context of our current social and digital culture. The focus has shifted towards the individual, where the learner is in control. Furthermore, with access to information, social networks and tools that allow learners to consume, share, and construct knowledge, the learning paradigm has changed. Our ability to learn what we need for tomorrow is more important than what we know today. A real challenge for any learning theory is to actuate known knowledge at the point of application. When knowledge, however, is needed, but not known, the ability to plug into sources to meet the requirements becomes a vital skill. As knowledge continues to grow and evolve, access to what is needed is more important than what the learner currently possesses (Siemens, 2012).
An effective option is found in blended learning programs delivering e-learning and instructor-led training. Many academic areas are discovering this to be also a good solution for traditional college teaching (Gonzales, 2004).
In present K-12 schools methods that align with the cognitive and behaviourist model, such as the lecture and traditional assessment methods, are still going strong. In the traditional classroom, these latter methods can still be effective, yet, in the context of open and online learning these pedagogies don’t work.
The differences between teaching in an online and face-to-face environment go beyond the individual skills involved. For example, Easton (2006) argued that online teachers need to undergo a paradigm shift in how they perceived time and space, managed instructional activities and assessments, and engaged with students. Virtual school experiences over the past decade have shown that effective virtual teachers have qualities and skills that often set them apart from traditional teachers. A good classroom teacher is not

necessarily a good online teacher. Although effective interaction with and support for students in these environments requires a unique set of skills and experiences, teacher education programs currently place very little emphasis on teaching and facilitation competencies for virtual school education. This should be a step in restructuring of educational systems in the digital age (Davies, 2013).
We considered that, when provided with quality professional development opportunities, good traditional teachers could also become effective facilitators of online learning. On the other hand, well-qualified and experienced online instructors can learn the more specialized instructional design and implementation skills that are necessary to create quality online learning materials based on their existing teaching experience and curricular expertise.

2. Project development

Most online designers and teachers have been trained in traditional instructional design systems. Online courses, as a consequence, have many elements identified in traditional instructional design literature. One problem when using traditional instructional design systems in online contexts is that development of these systems is the result of research completed in traditional classrooms. Online courses occur within a new context and the delivery system focuses on non-traditional media; therefore, we cannot assume traditional instructional design systems are appropriate in online contexts.
Our multidisciplinary design team included university teachers as content and pedagogy experts together with IT experts in instructional technology. The issues that had to be solved were grouped into three categories: pedagogy, technology, and assessment. The content team created scenarios on the subjects that were considered to be more difficult to understand or more appropriate for digitization. All multimedia materials created were hosted in the library of an e-learning platform that insured also the classroom management. The teaching materials were hybrid courses, combining the more traditional face-to-face instructional strategies with online learning, because they seem to offer higher completion rates and better quality learning outcomes than online courses alone.
Chemistry teachers were first trained to use the platform for learning and teaching activities, to use the library with educational materials, and the forum. We tried to make them feel comfortable when using the technology. The next step was dedicated to presenting materials created within the project frame to participants and to discuss their efficiency, as well as to identify various ways to improve quality. The trainees' opinions were expressed during those discussions and were centralized in a questionnaire.

3. Feedback

Some of the goals aimed by our survey were to summarize the critical e-learning issues related to the educational content and pedagogical approach and provide an overview of what works and what are the main features that recommend a lesson.
Overall, the survey participants found the web materials visually attractive, clear, and easy to navigate. They also gave positive ratings to the usefulness of resources in terms of understanding. In terms of scenarios quality, the participants rated characteristics such as visual clarity and appeal. The meaningful use of scenarios in terms of understanding the proposed topics also received positive ratings.
One of the questions of our survey was about the program element considered by our participants as being the most valuable (Figure 1). More than 40 % of the chemistry teachers considered that information obtained during the courses was the most important. Over 36 % of the respondents considered the digitized materials offered by our team as valuable. Only 3 % were interested in the strategies proposed by our program and about 18 % were happy for having the opportunity to share their teaching experiences and take advantage of the collaborative network created.
Another question aimed the motives that would prevent our trainees to constantly use the abilities gained during this program when teaching your students The answers showed confidence in the skills acquired during the course, 81 % being confident and very confident in the abilities obtained. The lack of available informatics laboratories and the lack of time necessary for planning the lessons were the main motives evoked by 61 %, and 47 % of the subjects respectively.
The participants to this survey were asked to point out the program element with the highest impact on learning activities (Figure 2). According to the opinion of about 63 % of the subjects working with the computer and the virtual experiences were the main elements enhancing learning. Almost 21 % considered that developing 21-st century competences is important for a good agreement with the young generation, 10 % valued IT methods for student assessment, and 6.5 % appreciated differentiated instruction as having the highest impact on learning.

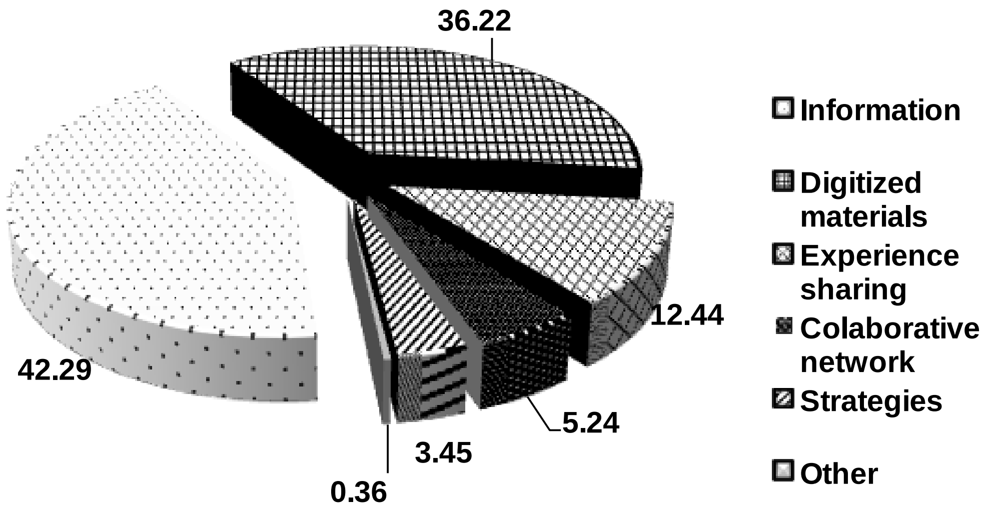

Figure 1: The most valuable element of the program according to the participants

Several chemistry teachers suggested that new learning materials were needed, focused on laboratory activities, providing the fundamental information about the main laboratory techniques and equipment.

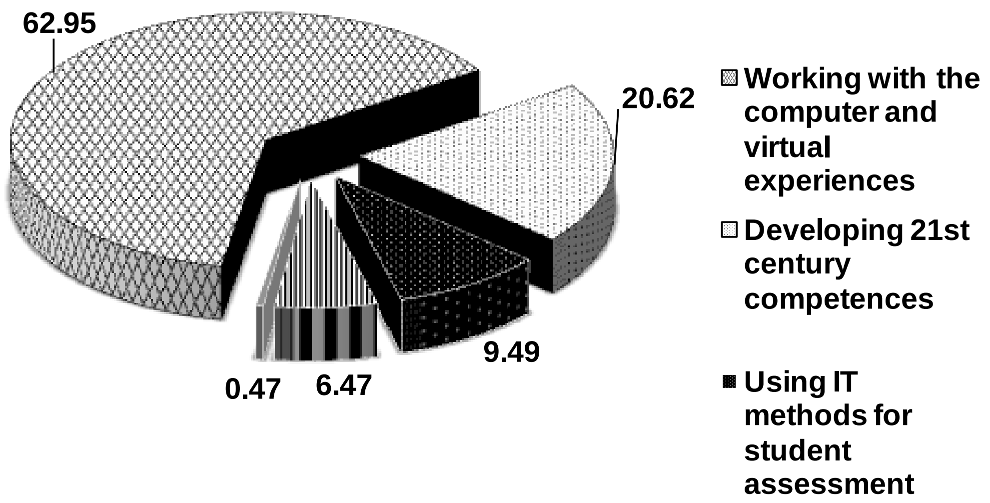

Figure 2: The program element with the highest impact upon learning activities

As a response to these requests, two new lessons were created. The first one deals with the common laboratory techniques and the other with spectral analysis methods in organic chemistry. We tried to create lessons which put the learner in control, with choices of how to participate, and access to open resources on the Web for content. The learner can choose the technique he is interested in, he can read or skip the theoretical background, then return and read again any part of the lesson he wants to.

The lesson presenting traditional laboratory techniques (Figure 3) describes the main separation operations: filtration, crystallization, distillation, and extraction. Each moment has three parts: there is a short theoretical background for each operation, followed by the description of the necessary equipment. Each item of the equipment is identified and magnified by clicking on it. The last part consists in building the laboratory installation and performing the operation (Figure 4).

Figure 3: Equipment description for laboratory distillation

Based on the assumption that a truly enterprise-wide approach to education combines the best aspects of on-line education with the best of instructor-led training (Gonzales, 2004), we considered that teaching basic fundamentals with e-learning could be followed by teaching advanced skills in the laboratory, with a face to face instructor. In our case, students should study at home the lesson and then, under the supervision of the chemistry teacher, they could build the laboratory installation and perform the operation.

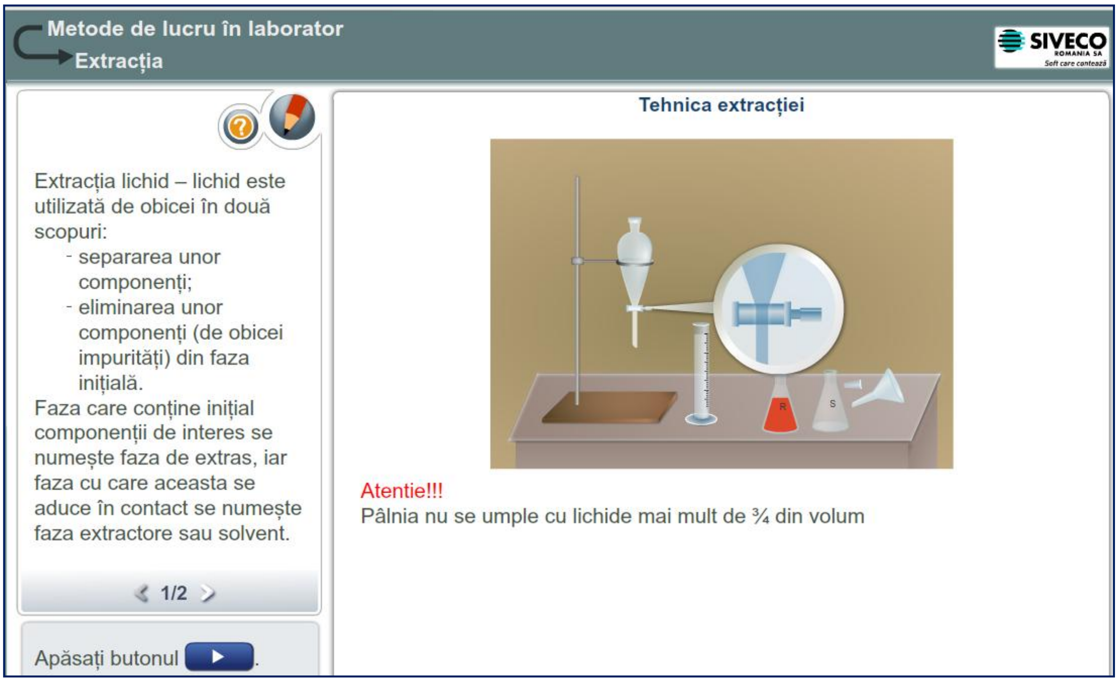

Figure 4: Building the laboratory installation for extraction

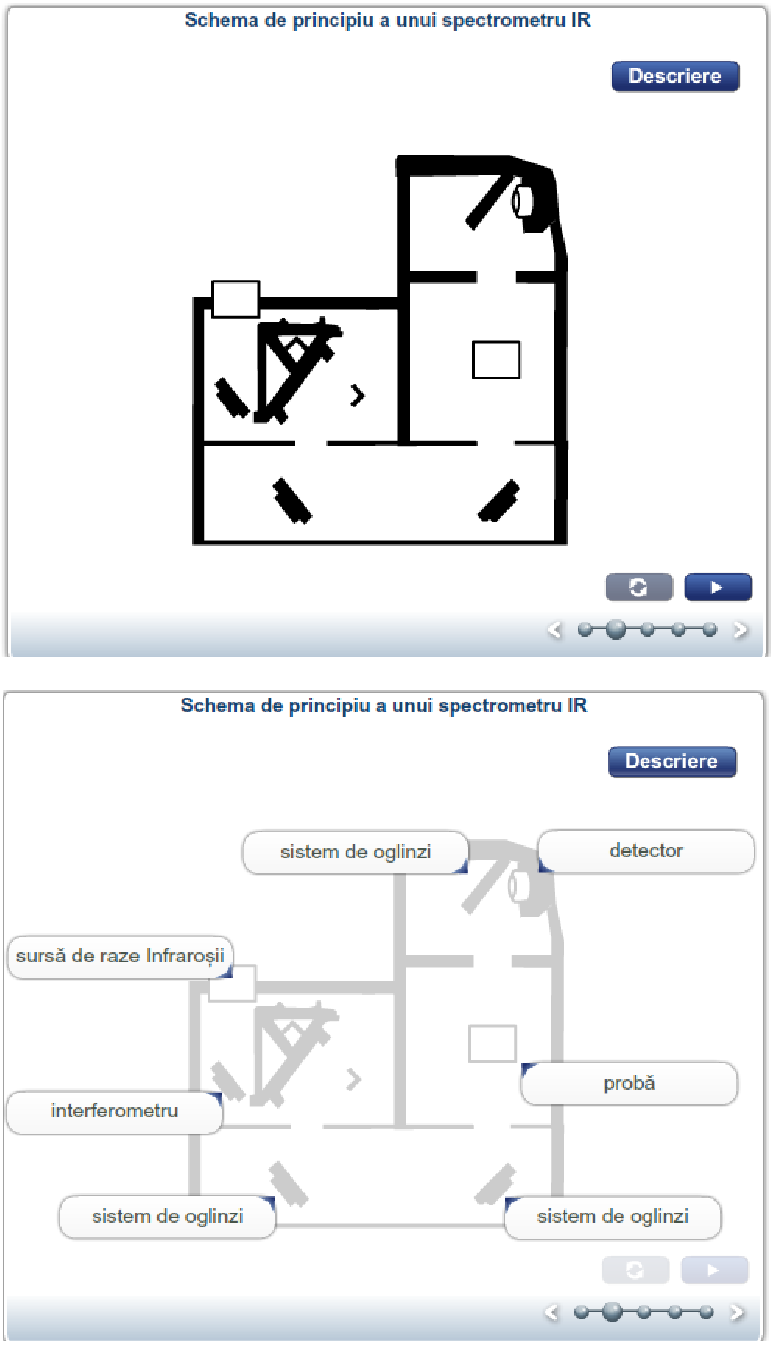

Figure 5: Schematic diagram of the IR spectrometer

The second lesson gives the fundamentals of spectral analysis methods in organic chemistry. It describes infrared spectroscopy, nuclear magnetic resonance spectroscopy, and mass spectrometry. All the moments begin with a short theoretical background, followed by the description of the apparatus used.

In the description we used a transparent layer for better visualization (Figure 5). We considered this way of explaining the parts of a device more effective than a simple numbered components list near the image. After giving other necessary information and one or more examples, the knowledge achieved was tested.

The experience gained through this project showed that including multimedia as part of K-12 instruction can significantly enhance student learning achievements. Thus, the conclusion is that multimedia learning technology should occupy a prominent place in the 21st century instructional toolbox, as research has shown it to be a significant tool for student engagement.

The results of our survey support the conclusion that when e-learning is deployed with high quality curriculum content and identical attention to the details that characterize high quality classic instruction, it can effectively complement, enhance, and expand educational options for K-12 students. It can also improve how and what students learn, and can deliver high-quality learning opportunities to all children.

4. Conclusion

e-learning is a powerful instructional strategy because it transcends the boundaries of traditional classroom instruction. In fact, it allows learning to occur at the student's initiative – any time, any place. e–learning also holds promise for promoting equity, by providing students with access to courses that otherwise might not be available, such as accelerated courses in remote rural areas.

Books and traditional strategies certainly will continue to be important, along with technologies such as telephones, satellites, computers, interactive TV, Internet, and compressed videos. But in all probability, today's newest educational technology approaches – e-learning and virtual schools – are destined to become tomorrow's established instructional delivery systems. e-Learning is about people using technology systems to support human learning. Although computers and other digital technologies will play an increasing role in K-12 schools, e-learning may work best when it is combined with certain degree of face-to-face classroom experience. In the future, an eventual goal for students might be to have their own notebook computers or tablets to support both in-school and at-home learning.

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