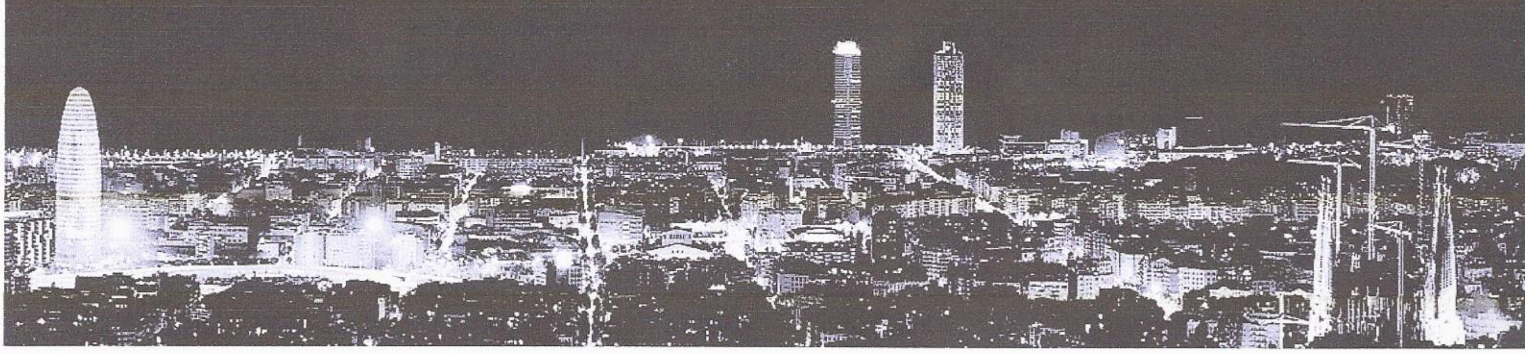
EDULEARN 17

9TH INTERNATIONAL CONFERENCE ON EDUCATION AND NEW LEARNING TECHNOLOGIES

BARCELONA (SPAIN)
3RD - 5TH OF JULY, 2017

CONFERENCE PROCEEDINGS



Published by
IATED Academy
iated.org

EDULEARN17 Proceedings
9th International Conference on Education and New Learning Technologies
July 3rd-5th, 2017 — Barcelona, Spain

Edited by
L. Gómez Chova, A. López Martínez, I. Candel Torres
IATED Academy

ISBN: 978-84-697-3777-4
ISSN: 2340-1117
Depósito Legal: V-1538-2017

Book cover designed by
J.L. Bernat

INORGANIC CHEMISTRY TEACHING MATERIALS FOR MOBILE LEARNING AND/OR "BRING YOUR OWN DEVICE" STRATEGY

Rosa Torregrosa Maciá[1], Miguel Molina Sabio[1], María Ángeles Lillo Ródenas[1,2], Joaquín Silvestre Albero[1], Ángel Berenguer Murcia[2], Ramiro Ruiz-Rosas[2], Isidro Martínez Mira[1], Eduardo Vilaplana Ortego[1], Olga Cornejo Navarro[1]

[1] Inorganic Chemistry Department, University of Alicante (SPAIN)
[2] University Materials Institute, University of Alicante (SPAIN)

Abstract

The study habits of millennial students are quite different from the students of past times. The new university student generations will need new teaching approaches adapted to their technological skills, with lap tops, tablets, smartphones, and so on, as tools for learning as its own pace, everywhere. In this communication, the adaptation of a collection of study materials, used in an Inorganic Chemistry Foundations topic, for their use in mobile learning and/or BYOD (Bring Your Own Device) strategy is presented. The materials are suited for the understanding of inorganic crystalline solids which, having crystalline structures (long range order), seem so difficult to visualize with 2D figures, as to understand their structural characteristics. The format of these materials was initially in PDF documents with 2D figures used for constructing models with little balls, following the steps in the text, on-site class in the laboratory. Later, the use of web pages with Java applets, running with JMol, introduced the students in a 3D visualization of the structure; clicking the different applet buttons student discovers the inner structure of the crystalline inorganic solids step by step. Both types of materials have been now brought up to date so that students would use them not only on-site classroom but also in every other time and place. Because JMol with Java doesn't run in mobile devices, it has been necessary to use JSMol and also re-write the HTML5 (HyperText Markup Language) code and CSS (Cascading Style Sheet) following the RWD (Responsive Web Design) approach. Programming the website to automatically respond to the user's preferences, it can be switching continuously image size and scripting abilities to accommodate for resolution, depending on the device used.

Keywords: Innovation, technology, teaching materials, Structural Inorganic Chemistry, mobile learning, RWD (Responsive Web Design), BYOD (Bring Your Own Device) strategy.

1 INTRODUCTION

Many reports on uses of ICT for learning are finding that the continued use and development of ICTs within education will have a strong impact on [1]:

- What is learned;
- How it is learned;
- When and where learning takes place;
- Who is learning and who is teaching.

Also, from "The New Multi-Screen World" Study made by Google [2], is emerging the reality that people are using multiple devices in a day, often switching between them to complete tasks and suggests that device choice depends on context, using two or three devices at the same time in countries like USA or UK.

On the other hand, the UNESCO believes that mobile technologies can expand and enrich educational opportunities for learners in diverse settings and published its policy guidelines for mobile learning in 2013 [3]. In this publication is defined what is mobile learning as "involving the use of mobile technology, either alone or in combination with other ICT (Information and Communication Technology), to enable learning anytime and anywhere". Because the mobile technology is constantly evolving, in these guidelines the UNESCO chooses to a broad definition of mobile devices, "recognizing simply that they are digital, easily portable, usually owned and controlled by an individual, rather than an institution, can access the internet, have multimedia capabilities, and can facilitate a large number of tasks, particularly those related to communication".

The use of certain type of ICT tool and, the possibility to use it in multiple devices applied to learning is known as multi-device-learning but, although most people think erroneously in Responsive eLearning when it comes [4], it is only about using the same learning tool in different devices. The term Responsive web design (RWD) refers to a web designing type for optimal viewing experiences, on different devices, by using technology to make design flexible and more adaptive to the media that renders them [5].

This kind of tool, Responsive eLearning, seems to be the only thing that. However, there is more to multi-device learning, than responsive eLearning. In his book Designing Multi Device Experiences, Michal Levin [6] defines three primary types of multi-device experiences that can be created when:

- Consistent: it is replicated across device types in terms of set content and core features.
- Continuous: it shifts between devices. It could be a continuation of the same action or progressing along a sequence of actions.
- Complementary: devices complement each other creating a new type of experience.

According to Brazuelo and Gallego [7], the mobile learning in Spain has been growing during the past five years, but it is still emerging. It should be needed to promote the mobile technologies regulating its use; encourage educational policies to implant these technologies; foster the creation of mobile learning contents; and the more important, prepare the teaching staff as a key element to really integrate the mobile technologies with educational purposes.

Because not only the study habits but also the ICT literacy of millennial students are quite different from the students of past times, it should be more difficult to achieve the teaching staff to be prepared to use new learning scenarios to which the students could be enrolled. The new university student generations will need new teaching approaches adapted to their technological skills, with lap tops, tablets, smartphones, and so on, as tools for learning as its own pace, everywhere.

Taking into account the above mentioned, being the authors of this work involved in teaching inorganic chemistry, consider that mobile learning can assist students to succeed in many difficult learning concepts in this topic bringing the means to do it as its own pace, everywhere.

3D vison is the main pitfall the students must face when learning structural inorganic chemistry. Using 2D drawings is not a good approach to give the students a clear mental idea about the structure of crystalline inorganic solids. 3D spinning structures would give a more realistic insight of, for example, crystalline structure of metals or other crystalline compounds.

2 OBJECTIVES

The main goal of this work is the design of teaching materials for structural inorganic chemistry applicable to mobile learning and/or BYOD (Bring Your Own Device) strategy.

To achieve this it should be necessary to focus our attention not only in the selection of academic content but also in the analysis of the technological tools the student will use. In this sense, the selection of the format these materials are going to be delivered and, the materials designing strategies, to better adequate the final format to the devices the student will use to learn with, are the particular objectives.

3 METHODOLOGY

To deal with the first particular objective, is necessary have a look at the state-of-the-art of technological ICT (Information and Communication Technology) tools applied to learning in order to find the most universal tools, affordable nowadays, whose use will enable us to achieve our main goal. Having done that, by analysing which type of design will be the most useful for mobile learning and/or BYOD strategy, we will be then capable to select the more adequate tool to tackle the second particular objective.

4 SELECTION OF THE ICT TOOL

4.1 State-of-the-art- and trends in Higher Education

Every year since 2004, The New Media Consortium and The EDUCASE Learning Initiative and EDUCASE Program publish “The Horizon Report: “Year” Higher Education Edition” where year by year it is shown three main aspects of technology related to HE (Higher Education): i) Key trends accelerating technology adoption in HE, ii) Significant Challenges impeding technology adoption in HE and, iii) Important developments in educational technology for HE [8], [9], [10].

The key trends accelerating HE technology adoption are in Tab. 1.

Table 1. *Key trends accelerating Higher Education technology adoption.*

	Trends		
Report	**Near-Term** **1 year or less**	**Mid-Term** **2-3 years**	**Far-Term** **4-5 years**
2015	- Increasing use of blended learning - Redesigning learning spaces	- Growing focus on measuring learning - Proliferation of Open educational resources	- Advancing cultures of change and innovation - Increasing cross-institution collaboration
2016	- Growing focus on measuring learning - Increasing use of blended learning designs	- Redesigning learning spaces - Shift deeper learning approaches	- Advancing cultures of change and innovation - Rethinking how institutions work
2017	- **<u>Blended learning designs</u>** - Collaborative learning	- Growing focus on measuring learning - **<u>Redesigning learning spaces</u>**	- Advancing cultures of change and innovation - Deeper learning approaches

Parallel to the key trends in Tab. 1, the NMC horizon report includes the horizon of adoption of important developments in technology for HE, recorded in Table 2.

Table 2. *Timeline for important developments in technology for Higher Education.*

	Time to adoption horizon		
Report	**1 year or less**	**2-3 years**	**4-5 years**
2015	- Bringing Your Own Device - Flipped Classroom	- Makerspaces - Wearable technology	- **<u>Adaptive learning technologies</u>** - The Internet of things (IoT)
2016	- Bringing Your Own Device - Learning analytics and adaptive learning	- Augmented and virtual reality - Makerspaces	- Affective computing - Robotics
2017	- **<u>Adaptive learning technologies</u>** - **<u>Mobile learning</u>**	- The Internet of things (IoT) - Next-generation LMS	- Artificial intelligence - Natural users interfaces

From Tabs. 1 and 2 it is noticed that in a near-term from 2017 is expected that blended learning designs will accelerate HE technology adoption and, the more important developments in technology for HE will be the adaptive learning technologies and mobile learning.

The concept of adaptive learning technologies is connected to an education technology that can respond to a student's interactions in real-time by automatically providing the student with individual support. The tools used to perform the real-time responses to the student actions can be designed to actuate in three ways: adapting the content, the assessment or the sequence of learning offered.

Adaptive learning refers to the technologies monitoring student progress, using data to modify instruction at any time [10]. Accordingly with EDUCAUSE these technologies “dynamically adjust to the level or type of course content based on an individual’s abilities or skill attainment, in ways that accelerate a learner’s performance with both automated and instructor interventions of course content based on an individual’s abilities or skill attainment, in ways that accelerate a learner’s performance with both automated and instructor interventions” [11].

4.2 Selection of the technology and design strategy of the tool

We decided to choose mobile learning as the technology to be used for our students to learning about structural inorganic chemistry and, the type of ICT tool designed to learning will be a web.

Having choose the mobile learning technology to deliver the learning materials, we must analyse how should behave these web pages in the different kinds of mobile devices. The design of the web must be done accordingly to adaptive learning technologies if we want students have a pleasant and engaging learning experience. We develop the content of the web pages including JSMol applets in order to present spatially the 3D organization of crystalline inorganic solids and, the directions to visualize important structural aspects of them. But we do not have enough knowledge about responsive web design (RWD). Because of that, the template of the web pages was developed by computer experts from the Taller Digital of the General Foundation of the University of Alicante, starting from a previous web site containing the same learning materials but with a static design and with Jmol applets requiring Java.

5 PLANNING AND DEVELOPPING THE STRUCTURAL INORGANIC CHEMISTRY CONTENT

Structural aspects of inorganic substances are frequently involved in the different teaching topics of the Inorganic Chemistry Department. To initiate the students in the difficult task to visualize and understand the basic structures, like those of metals, it must be considered the use of PDB files containing structural information mainly obtained by XR Diffraction. The structures of metals in the Periodic Table are introduced in subsequent web pages ranging from close-packed structures like face-centred cubic or hexagonal close-packed until the body-centred cubic and, simple cubic, less dense structures. Each structure is analysed in detail by selecting a collection of script buttons that change de features showed in the applet window. The students can go forth and back and repeat all the buttons as they need to revisit the visualization until finally they get understand what they are visualizing in the applet window. To write the scripts in every button it should be investigate in the PDB file in order to annotate the number of the atoms that are involucrate in every structural feature visualized under each radio button and then write the corresponding JSMol script.

Additionally, the structure of simple ionic crystalline solids is included. The strategy to analyse the structure of this type of solids is to visualize the order of the big ions compared to the metallic structures. The little ions will be then occupying the interstices of the big ion net, depending on the radio ratio between the little to the big ion.

6 RESULTS

Fig. 1 shows the screen of a windows10 PC, together with a mini-iPAD, an android smartphone and a Win10 tablet-PC. As it can be seen, all of them present the same image in the screen without distortions, independently of the dimensions of the screen. Enlargement of Fig. 1 allows to appreciate that the web pages were constructed not only in Spanish but also in English.

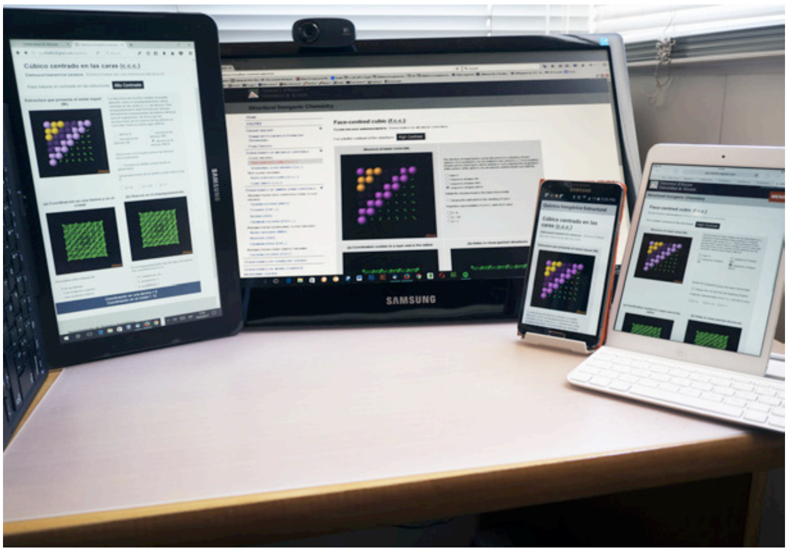


Figure 1. Different devices showing the same screen without distortions or deformations, independently of the orientation and size of the screen.

The best way to present you our results is to access the web pages and experience the learning materials on your own. The content of the Menu is the following:

Menu:

Group Theory: Symmetry Elements and Symmetry Operations

Structure of Metallic Crystals:

- Close-Packing:
  - Face-centred cubic (f.c.c.)
  - Hexagonal close packing (h.c.)
- Not close packing:
  - Body-centred cubic (b.c.c.)
  - Cubic simple (c.s.)

Structure of simple ionic crystals:

- Arising from face-centred cubic close packing:
  - Sodium Chloride (NaCl)
  - Fluorite (CaF_2)
  - Blende (ZnS)
  - Cadmium Chloride ($CdCl_2$)
- Arising from hexagonal close packing:
  - Nickel Arsenide (NiAs)
  - Wurtzite (ZnS)
  - Cadmium Iodide (CdI_2)

Arising from cubic simple packing:

- Caesium Chloride (CsCl)

The English web page can be accessed here (a link to the page in Spanish is also available):

https://dqino.ua.es/en/virtual-lab/struct-inorg-chem/

It can also be accessed by means of this QR code:

ACKNOWLEDGEMENTS

Authors acknowledge the support of Vicerrectorado de Calidad e Innovación Educativa of the Universidad de Alicante through the Programa Redes del Instituto de Ciencias de la Educación (ICE).

REFERENCES

[1] Kalaimati, H. and Lizzie, J., “ICT Infusion-Changing Face of Teaching-Learning Process”, in “Emerging trends in Digital Era through educational technology”, Dr. Manichander, T., Editorial Lulu.com (2016).

[2] Google 2012, ‘The New Multi-Screen World Study’, retrieved 15 May 2017, <https://www.thinkwithgoogle.com/research-studies/the-newmulti-screen-world-study.html>

[3] UNESCO. “Policy Guidelines for Mobile Learning”. 2013. Retrieved may 2017, <http://unesdoc.unesco.org/images/0021/002196/219641E.pdf>.

[4] Garg, Amit, “Multi-device Learning”, *TRAINING & DEVELOPMENT* : WWW.AITD.COM.AU, AUGUST 2015.

[5] “Responsive eLearning. Design & development” e-book, UPSIDE Learning, retrived in 15 May 2017,<https://www.google.es/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=0ahUKEwit-ZjrsPfTAhXJKMAKHbxpCCkQFghFMAM&url=https%3A%2F%2Fwww.elearningguild.com%2Fshowfile.cfm%3Fid%3D5364&usg=AFQjCNFqZhytNMbiXkHbp5rfgYPsV5YaQw&cad=rja>

[6] Levin, M. 2014, ‘Designing Multi-Device Experiences’ O’Reilly Media, Massachusetts.

[7] Brazuelo Grund, F. and Gallego Gil, F. J., “Estado del Mobile Learning en España”, Educar em Revista, Curitiba, Brasil, Edição Especial n. 4/2014, p. 99-128. Editora UFPR.

[8] NMC Horizon Report > 2015 Higher Education Edition, retrieved 15 May < http://www.nmc.org/publication/nmc-horizon-report-2015-higher-education-edition/>

[9] NMC Horizon Report > 2016 Higher Education Edition, retrieved 15 May <http://www.nmc.org/publication/nmc-horizon-report-2016-higher-education-edition/>

[10] NMC Horizon Report > 2017 Higher Education Edition, retrieved 15 May <http://www.nmc.org/publication/nmc-horizon-report-2017-higher-education-edition/>

[11] EDUCAUSE Review Article “Adapting learning systems: Surviving the storm”, retrieved 15 May <http://er.educause.edu/articles/2016/10/adaptive-learning-systems-surviving-the-storm>