An Integrated Use of the Interactive Whiteboard and Experiments

A science dissertation, within the framework of the "Chemistry is All Around" project

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Abstract

The current context [1] shows that ICT are increasingly present in everyday life. In this respect, education tries to integrate ICT in classes [2 and 3]. An interesting evolution must be emphasised in the diffusion of ICT [4 and 5], but the path is still long. ICT, and particularly the IWB, belong in the investigation approach [6] and enhance each phase students go through. Moreover, ICT have many benefits that can be sorted in the four poles of use described by Bétrancourt [7]. According to Duroisin [9], the interactivity searched with the IWB, and broadly speaking ICT, make it possible to develop interactions within the class, help the teacher make learning more individual and thus homogenise students' performances. Thanks to an observation internship carried out in the United Kingdom, it was observed that teachers make little use of the interactivity of the IWB but made up for this loss with the interactivity of other ICT tools present in the classroom. Based on these observations, the experiment carried out in a 3rd year class, socio-educational transition, aimed to implement sequences that intelligently integrated the IWB and ICT resources in order to foster interactions in class to improve learning. At the end of this experiment, using questionnaires, it emerges that the structuration phase remains a key moment in the integration of concepts, even though they have been gradually discovered throughout the sequence. It also emerges that ICT really motivate students and therefore foster their involvement in the lesson. Finally, in spite of the objective targeted during the creation of the sequences, the IWB-students interactivity was not sufficiently encountered, showing that implementing this approach is difficult. At the end of this work, it can be concluded that the IWB integrates perfectly in the investigative approach carried out during science lessons, that adapting a "traditional" lesson to the IWB is not enough, but that the lesson needs to be rethought from top to bottom and that fostering students-IWB interaction is crucial. This work opens the way to other research possibilities such as developing a sequence that is similar to those already created, but in which laboratory experiments are central; or else creating a leaflet addressed to teachers with intelligent methods to use ICT in education.

1. Context

According to the latest report by AWT [1], 77% of Walloon families have an Internet connection 82% of the families consider that information and communication technologies need to be commanded in primary or secondary school". Those figures fit in the reflexion on contemporary society.

The experiment carried out is also part of the current political framework. Indeed in 1997, the decree "Missions" [2] updated the missions of education in the *Fédération Wallonie-Bruxelles* (the French-speaking Community of Belgium). Article 8 states:

> To meet the general objectives of article 6, knowledge and know-how, whether they are built by the students or transmitted, are part of the approach of skill acquisition. (…) For this purpose, the French-speaking Community for education, and any other authority for subsided education, make sure every school: (...) uses information and communication technologies, insofar as they are tools of development, of access to autonomy and individuation of learning paths; (CFWB, 1997, article 8)

Since this decree was established, the Fédération Wallonie-Bruxelles has set up various schemes to develop ICT in education. The latest one, created in 2011 [3], is the project "Ecole Numérique" to build tomorrow's school.

Thanks to the different actions, the number of computers in secondary schools classroom and the number of interactive whiteboards have increased. According to the AWT report [5] and "Survey of schools: ICT in

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education" [4], there were ten students per computer in 2009, for 7 in 2013. The number of IWB in Walloon classrooms reached 2032 in 2013, which is a 758% increase as compared to 2009. Wallonia remains below the European average [4], but those figures are promising and make this work all the more important.

2. Integrating ICT in the investigative approach

Information and communication technologies are relevant in the framework of a science lesson, particularly in chemistry, because they fit perfectly in the investigative approach we seek to implement.
According to educationalists, the investigative approach developed for science classes is structured in different ways and includes a more or less large number of steps. For this work, the chosen approach is that proposed by the non-profit organisation "ASBL HYPOThèse" [6]. It is divided in four steps:

- the awareness phase, during which the IWB and ICT put learning into context, bringing up a problem situation that cannot be directly experienced by students. This problem situation can be presented with videos, pictures, animations... It must be added that ICT tool cannot be integrated at the cost of experimentation experienced by students in the classroom or in everyday life.
- the questioning and hypotheses phase, during which the IWB helps collect and save information. Thus, students can write their questions and hypotheses on the IWB. The file can be saved and students can go back to it when it is time to answer their initial questions after the experimentation or research phase. Students can easily see the questions they initially had and answer them. They can also confront their hypotheses to their discoveries.
- the research phase, which includes the whole investigation conducted by the students. It can be refined, specifying which type of research it is.
    - Experimenting: like in the awareness phase, ICT must be used during the experimentation in relation to concrete manipulation or replace the latter if it cannot be done, for example when an experiment is too dangerous to be done in class. In this case it can be presented with a video projected on the IWB and analysed with the different tools available (freeze frame, screen capture of different steps…).
    - Observing: ICT can provide an extra approach to details in comparison to observation in class. For example, a colour image of a microscopic biological preparation can be projected. What is seen can then be analysed and understood.
    - Modelling: thanks to precise applications, ICT bring a certain form of modelling: virtual modelling. Once again, virtual modelling must not replace concrete modelling (with material in the classroom), but it can offer a new dimension to the notions discovered. For this purpose, it is possible to conduct a reflexion on the space of virtual modelling: before or after concrete modelling? For my part, I think concrete modelling must be privileged so that students can imagine with the material at their disposal. Then, virtual modelling can enhance their vision and what they imagined. One downside of virtual modelling is that the representation is usually pre-programmed, leaving less room to research and imagination.
    - Searching in documents: connected to the Internet, ICT are an inexhaustible information source. However, it is important that teachers be able to help students use the Internet correctly and safely.
    - Consulting a resource person: for this last type of research, students could be able to discuss through the Internet with different resource people.
- Reinvestment phase: during this phase, students can use the IWB to structure on their own what they have learnt. They write their definitions and theoretical notions. Exercises can also be corrected there with an extra dimension to what is written in their lesson sheets, such as extra information. The approach is here presented in a linear way, yet, in practice, toings and froings are possible between the steps.

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3. ICT benefits following four poles

According to Bétrancourt [7], it is possible to highlight four major uses of ICT. Within the framework of this work, the four poles presented are analysed and described with more precisions in the perspective of the investigative approach developed in science courses.

- Information storage: as previously explained, the IWB (and the computer connected to it) allows saving students' contributions and reflexions. The questions and hypotheses are recovered in the beginning of the sequence and can be analysed at the end to foster metacognition and become aware of the progress they have made.
- Information visualisation: this pole enhances students' mental representations. Indeed, information can be presented in several forms to the students; an image, a video, an animation, a chart… Moreover, the IWB provides colour (which can foster learning) as compared to students' lesson sheets, usually black and white.
- Production and creation process: the IWB and how it is used are only limited by our imagination. By way of example: it is possible to present a more structural approach [10] to matter (macro- and microscopic level), and then to provide a temporal aspect of the phenomenon and thus provide dynamics through an animation.
- Automatic processing of complex information: this last use highlights the fact that it is possible to carry out mathematical calculations that could not be made within a decent time limit and without the help of tools. Thus, a spreadsheet can be used to quickly create accurate tables and charts. Accurate animations can be used to illustrate certain more complex notions in mathematics, for instance.

At the junction between those four poles lies interactivity [8]. Indeed, according to Duroisin [9], interactivity between the IWB and students fosters the motivation of the latters, who are more involved in their work. She also observes that interactions are increasing in class and that the teacher's attitude is more individualised. Regarding students' performances, those observed facts translate into a greater homogeneity of results [9].

4. Comparison between Belgium and the United Kingdom

To enhance this work and the possible conclusions drawn from it, I spent one week in the United Kingdom to observe classes. My observations took place in five different schools of the region of Portsmouth in February 2014. Obviously, those observations are not representative of a greater number of schools and cannot be extrapolated. However, they allow certain analyses. Moreover, I could collect much information thanks to questionnaires completed by the English teachers and students. I also handed those questionnaires to Belgian teachers and students to compare their results and in this way understand the differences between our practices.

Belgium	United Kingdom
26 students	77 students
5 teachers	9 teachers
46% of students say they attend lessons using the IWB fewer than once a week (or even never).	93% of students say all the lessons they attend use the IWB.
20% of teachers use the IWB for every lesson.	78% of teachers use the IWB for every lesson.
	Only 35% of teachers say they often send students to work with the IWB.
80% of teachers think the IWB has an impact on students' motivation.	78% of teachers think the IWB has an impact on students' motivation.

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Considering those figures, teachers are ahead in term of ICT use in comparison to Belgian teachers. It can be explained by the policy regarding ICT equipment in English classes conducted since 2000.
Despite the presence of IWB in most classes, it was observed that English teachers make little use of the major argument in favour of the IWB: interactivity. Yet, we have observed that interactivity is the main strength of the IWB, improving the students' learning conditions. However, although the interactivity not used with the IWB, is recovered through the use of other ICT tools used in the classroom (tablets, laptops, iPod…).

5. Experimentation

Thanks to the experimentation conducted, three sequences in chemistry with direct reference to the curriculum were developed [11]: metals and nonmetals; ions, anions, cations; molecular formula.
Through those three sequences that fully use the IWB, four animations were tested and assessed.

5.1. Experiment context

Those sequences were used with twelve students in a 3rd year class, socio-educational transition at *Institut Sainte-Thérèse D'Avila* between the 10th of March and the 4th of April 2014, with three hours of chemistry per week, thus a total of twelve hours.

5.2. Questionnaires

In order to evaluate the sequences and animations, questionnaires were handed to the students in the class. Initially, the questionnaires should have been complete on the online platform Google Drive, but the students were not in favour of this method.
Two types of questionnaire were submitted to them:

- the questionnaire to assess the whole sequence trying to identify the moment that contributed most to their learning. The students thus completed three such questionnaires (one per sequence).
- the questionnaire to assess a specific animation and whether it helps understand the targeted concepts. This questionnaire is adapted from the WP2.C questionnaire of the "Chemistry is All Around Network" project. The students completed four such questionnaires (one per animation).

In order to assess the animations, I too complete four WP2.B questionnaires.

5.3. Results

Based on the average results obtained for the animation reviews, several pieces of information emerge. A large majority of students say they are motivated when they use ICT resource on the IWB. This result really encourages one to continue the development of ICT tools.
Thanks to the questionnaires to assess the whole sequences, it is possible to compare the results for a same question for the three sequences experimented. We can thus note that a key moment in the discovery of notions remains the

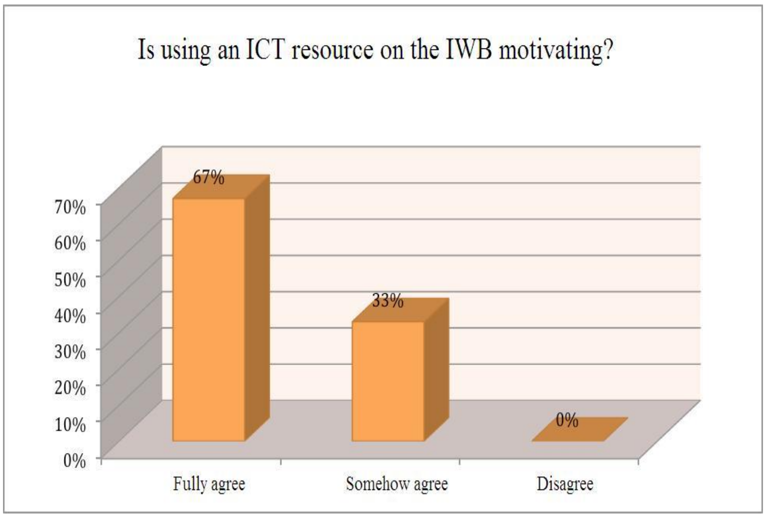

Figure 1: chart showing the average students' answers to the question "Is using an ICT resource on the IWB motivating?"

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structuration phase and the formulation of the theory, when the concepts were gradually discovered during the research phase. One can assume that students only become aware of the notions significance when these are structured; the theory formulation phase is thus important for them.

It was observed that although there is a will to create sequences that emphasise interactivity between the IWB and students, this aim was not fully met. This proves that implementing such a sequence remains difficult and that in-depth work still needs to be though through at this level.

5.4. Criticisms

First of all, the questionnaires given to the students are quite long and detailed. Completing them takes time and students can easily lose their way, giving information that does not always match with other. Bias can appear at this level.

Depending on the time available, the questionnaires were not always completed right after the activity to assess. Thence, some students did not remember what they had experienced and mixed up some of the activities, which biased some of the results.

The information was collected in only one twelve-student class.

6. Conclusions of the approach and prospects

It is certainly possible to refine the result analysis and their interpretation, but here are the main conclusions of this work.

6.1. Conclusions

Firstly, the IWB fits perfectly in the investigative approach at any moment. It is one strength of this tool. However, it should not be used at the cost of real-life experience or concrete manipulation by students.

In order to integrate the IWB in a sequence, adapting a so-called “traditional” sequence to use the IWB at several moments is not enough. On the contrary, the sequence needs to be rethought from top to bottom paying attention to the place of the IWB in the teaching sequence and developing a correspondence between lesson sheets and the IWB.

Finally, to foster students’ motivation and thus their participation, the IWB must be developed highlighting its interactive component. Interactions between the IWB and students (and to a lesser extent, but still necessary, interactions between teachers and students, between students themselves) must be privileged.

6.2. Openings

Such a subject opens doors to infinite research. This work is but a springboard to other researches to refine the use of ICT in science classes.

Thus, among the possible future projects, one could imagine developing other chemistry sequences in which lab experimentation would be more important in order to consider how the IWB can help better understand phenomena. Another possibility would be to create a leaflet addressed to teachers with intelligent methods to use ICT in education. Finally, one could consider creating real interactive chemistry e-books to help learning abstract concepts.

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