THE CONTRIBUTION OF THE INTERACTIVE WHITEBOARD IN TEACHING AND LEARNING PHYSICS

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Abstract. The Physics teaching process is often based on providing just the information, without telling the student how to put things in practice. The students take the information, memorize and reproduce it, in order to pass exams, without being able to apply the theory in real life situations. Under these circumstances the student is seen only as a consumer of information. New technologies such as interactive whiteboard help the teacher to change student perceptions of learning physics, making the teaching and learning process interactive and focusing on the student. The interactive whiteboard attracts the student in an interactive learning process in which he is able to build his own knowledge. The aim of this paper is to outline the role of the interactive whiteboard in changing the student’s attitude towards the physics lessons.

Key words: interactive teaching, interactive learning, interactive whiteboard - interactive tool.

1. INTRODUCTION

The modern economics are based on an advanced technology, which cannot develop unless there is a workforce situated at a high level of understanding and technical competences.

Students confront themselves with a world which requires new competences and abilities [1]. The traditional Physics courses do not create the abilities that students need after graduation. For this reason, these courses become inefficient. The interactive teaching methods accompanied by new interactive tools can improve the efficiency of the course. These methods differ from the traditional ones; they mean the combination between the teacher’s strategies and the student’s learning style [2]. In this way, the teacher-centred approach can be replaced with a student-centred approach [3]. The presentation of the instructional content based on the interactive content can be realised with the help of technology [1]. The new tools that the digital technology is offering allow teachers and pupils to engage in
the development of the lesson [3]. The introduction of the technology in schools contributes to the training of the future. The technology itself does not improve learning, but it improves the way in which this technology can lead to the student’s change of attitude regarding learning [4].

1.1. THE CONSTRUCTIVE APPROACH TO TEACHING AND LEARNING – THE THEORETICAL FRAMEWORK

The constructivism theory of learning is based on the vision that the student builds a new understanding on the basis of a synthesis between the previous knowledge and the new information obtained from exploration, investigation and discussions [5]. In the constructivism vision, the teacher should not be concerned by the amount of information that should the students receive, but by the way this information arrives to the students [6]. The role of the teacher is to facilitate the building of the knowledge’s scheme for students and to ensure that they take control over their own training [7]. The teacher should create a certain climate for learning by choosing experiments, problems and discussions and especially by introducing technology during the instruction process [2]. The teacher has to create an environment in which students can interact between them and, between the lesson and them, an environment where the curiosity of the students is more important than the achieved content [8]. In an interactive learning, students spend much more time with activities which require thinking and responsibility [9]. The interactive instruction is realised using interactive tools. The interactive whiteboard is one of the most powerful tools that can bring changes in teaching and learning physics if used in an efficient way [8].

The interactive whiteboard is called “interactive” because it encourages students to interact with the presented material [8]. The interactive whiteboard allows the user to integrate various multimedia applications, to search for a Website, to watch a didactic movie, to make a presentation [10]. The interactive whiteboard’s efficiency is due to the interactive soft Notebook [8]. This has functions that allow moving objects in different areas of the whiteboard, using some special virtual markers like “Magic Pen” which highlights a certain part from the screen, access to the majority of the objects from the clip art and multimedia applications taken from “Educational images gallery” [11]. By working in groups, the students can make digital projects, which are presented at the interactive whiteboard. The students and their teachers spend less time when they prepare the different materials needed for the teaching activities, as they have many sources at their disposal in the IWB’s library [12].

Furthermore, the interactive whiteboard allows the integration of some software that helps students make different applications on their own or in a team [8]. For example: Scratch-software for animation [13]. Smart Ideas software was used for making conceptual maps.
2. THE METHOD

The physics labs from our college were equipped with state-of-the-art equipment (computers, interactive whiteboards, equipments with acquisition and processing data) after a sponsorship project funded by TIMKEN Foundation from Ohio, USA was made. Through this donation, the TIMKEN Foundation showed interest in the young generation, because our country’s future depends on their training.

The aim of this study is to find out if the interactive whiteboard’s use during the physics lessons changes the student’s attitude regarding their active participation in the physics classes. The training lasted three months and the interactive whiteboard was used during the Physics classes. After that, a questionnaire inspired by the surveys from the research studies of Beeland [14], Morgan [5] and Vetter [15] was applied to the study sample. All these questionnaires are based on Christensen and Knezek’s surveys [16].

The study sample consists of 60 students aged between 17 and 18, studying in mathematics-computing classes. The students have learned to use the interactive whiteboard by following the indications of SMART Notebook collaborative learning software [17]. During Physics classes, images, animations from the multimedia gallery, didactic movies from YouTube were integrated in lessons in order to exemplify certain phenomena such as the resonance. The interactive whiteboard is an instrument which offers interdisciplinary instruction, during which the students are encouraged to developing strong knowledge connections. Education is valuable only if it satisfies the needs of those who learn. Education has to help the student to find answers at the real-life problems [18]. The interdisciplinary way of teaching becomes more and more influential because the students perceive the subjects that are detached from the real world [19]. Therefore, we used the interactive whiteboard and the didactic conceptual map to study the subject called ‘the interaction of the radiations with the substance’, which can be applied especially in medicine. The conceptual map is seen as a visual presentation of the knowledge and the ways of argumentation. The use of the conceptual maps promotes the active and conscious learning and it also appeals to the previous knowledge of the student [20].

The conceptual maps, which present themselves as knowledge networks, make it easier to understand and apply knowledge in the daily life [5].

The conceptual map is a strategy which promotes learning in a team, as students are encouraged to express their opinions related to the presented concepts [21].

After the basics of the photoelectric effect have been discussed, the students were explained both the applications from the workbook (such as the photoelectric cell or the photomultiplier) and the applications of the quantum phenomena in medical imaging. By using the Smart Ideas 5 software, the students could make conceptual maps related to the interaction of radiation with substance, the photoelectric effect and they analysed them at the interactive whiteboard. For the realization of these conceptual maps, the students used the information [22, 23].
Figure 1 shows a conceptual map which represents the interaction of radiation with the substance.

![Conceptual Map](image-url)

**Fig. 1 – Conceptual map The interaction of radiation with substance.**
In order to make students interested in the teaching of quantum phenomena, the focus was on the interaction of X-rays with the substance and with the phenomena of absorption and scattering of the rays when they are used in the diagnostic imagining. We noticed that, in the moment when radiography is realised, the important effects are the photoelectric effect and the Compton Effect [24]. We also emphasised the fact that elastic scatterings of these rays are possible, only these types of scatterings do not have major implications for the diagnostic imagining [22]. The elastic scattering reduces the number of the X-rays that reach the detector, as well as it alters the X-rays’s trajectory between the source and the detector, in case of radiography. It may produce a slight “fogging” of the film [24].

The realisation and the analysis of these conceptual maps on the interactive whiteboard have given the students the opportunity to make the connection with what they already knew from practising about the way radiography is made. Thereby, they paid more attention on the fact that, when the radiation gets through the human body, it will not be deviated, it can be absorbed through the photoelectric effect or it can be elastically scattered or scattered through the Compton Effect [22].

Figure 2 highlights a conceptual map of the photoelectric effect. By analysing this conceptual map, it is noticed that the probability of the photoelectric effect increases with the element’s atomic number. It results from this, that materials such as lead (with $Z = 82$) absorb X-rays. For this reason, lead is used to manufacture aprons, to cover the parts of body that are exposed to the X-rays during the diagnosis with X-rays. Furthermore, it can be proved that the soft tissues consisting of the lighter elements such as carbon ($Z = 6$), nitrogen ($Z = 7$), oxygen ($Z = 8$) and hydrogen ($Z = 1$), with $Z_{med} = 7.4$, are less likely to absorb photons through the photoelectric effect. Instead, the bones, which are made of calcium ($Z = 20$) and phosphorus atoms ($Z = 15$) as their main elements, have $Z_{med} = 12.7$ and are more likely to absorb the X-rays through photoelectric effect. By using images which reproduce radiographs from the interactive whiteboards, it can be explained why the film used at radiography is less exposed behind the bone tissue than behind the soft tissues [23]. In this way we insist on the fact that the photoelectric effect gives us the image of the organ exposed to X-rays. If all the X-rays passed through the patient’s body, we would obtain a uniformly dark image and if the rays were totally absorbed, then the image would be uniformly white. Bones appear white on X-ray images and the soft tissues are darker [24]. In addition, the conceptual map emphasized how the specific X-rays are produced, after rearranging the electronic shell, due to the fact that the electron has been ejected from an inner orbit of the atom. It has been made a connection with the student’s knowledge about X-rays spectra.
Fig. 2 – Conceptual map Photoelectric effect. The colored versions could be accessed at http://www.rrp.infin.ro.

By using the Scratch software [13], the students made animations such as the one which shows the tracing of light rays in a periscope, as shown in Fig. 3.
The students made several projects using different techniques offered by the Notebook 10 software [11], such as moving objects, integrating labels, creating hyperlinks, using a Magnifying Glass in order to find out the answer at different questions or the Magic Tunnel to discover certain notions. In Fig. 4 is represented a part from a project where a Magnifying Glass is used.

![Fig. 4 – How to use a magnifier in order to find out the formula for the magnetic flux: a) hidden formula; b) revealed formula.](image)

Figure 5 and 6 show parts from a project where the Magic Tunnel was used in order to determine the formulas for the magnetic field created by the stationary electric currents.
In addition, the interactive whiteboard allows seeing the graphics realised during a computer-assisted experiment, so the student can concentrate more on the
phenomenon he/she studies [25]. The computer-assisted experiments give the students the possibility to realise the experiment, to measure different physical quantities and to notice the evolution of physical quantities in real time [26]. The computer-assisted experiment allows students to reflect more at the relevant physical aspects, to focus on research due to the fact that they are exempt from the data purchase. The data is presented graphically in real time, so the students can receive feedback immediately and see the data in an understandable form [27]. A disadvantage of the computer-assisted experiment is the high cost of the equipment so this kind of experiments cannot be made by every single student. This problem can be resolved by using the interactive whiteboard, due to the fact that the variation in time of the physical quantities can be seen by the whole classroom and the graphics can be processed. Figure 7 presents the graphic of the temperature variation in time for an object made of iron in the computer assisted experiment called Heat capacity of metals, seen at the interactive whiteboard. For conducting experiments we have used an experimental setup COBRA 3 (Phywe System GMBH&Co.KG, Germany) equipped with data acquisition sensors and processing software.

Fig. 7 – Graph of temperature evolution in time for an iron object for the computer assisted experiment called Heat capacity of metals. The colored versions could be accessed at http://www.rrp.infiim.ro.
Analysing the data from the graph presented in Fig. 7, the students have calculated the specific heat of an iron body. The iron body which is heated up to the temperature of 100 degrees is introduced in a calorimeter full of cold water. The heat exchange between the hot body and the water together with the calorimeter leads to an equilibrium characterized by a constant temperature, as shown in the graphic. It can be noticed from the graphic that the temperature increases from \( t_2 = 26.21 \, ^\circ C \) to the equilibrium temperature \( t_m = 30.39 \, ^\circ C \) during the establishment of the balance. By using the results from the table, the students can draw the graphic and compare with the one offered by the computer. The specific heat capacity results from the calorimetric equation:

\[
Q_{\text{transmitted}} = Q_{\text{received}},
\]

\[
\begin{align*}
Q_{\text{transmitted}} &= m_2 c_2 (t_2 - t_m), \\
Q_{\text{received}} &= (C + m_1 c_1)(t_2 - t_m), \\
c_2 &= \frac{(C + m_1 c_1)(t_m - t_1)}{m_2 (t_2 - t_m)},
\end{align*}
\]

where: \( C = 80 \, J/K = \text{heat capacity of the calorimeter} \); \( c_1 = 4185 \, J/kg \, K = \text{specific heat capacity of water} \); \( m_1 = 200 \, g = \text{mass of water} \); \( m_2 = 120 \, g = \text{mass of the iron body} \);

\[
c_2 = \frac{(80 + 0.2 \cdot 4185)(30.39 - 26.21)}{0.12(100 - 30.39)} = 459.04 \, J/kg \, K [28].
\]

3. RESULTS AND DISCUSSION

The dependent variable in this study was students’ engagement in learning Physics when an interactive whiteboard is used in the teaching process. The students have responded to twenty questions on a 1 to 4 scale. The significance of the answers was: 1 indicates that the student strongly disagrees with the statement, 2 means significant disagreement, 3 means agreement, and 4 strong agreements. Table 1 indicates the average rating of the responses for each question.

Table 1

<table>
<thead>
<tr>
<th>Question</th>
<th>Average rating</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I enjoy using the interactive whiteboard during Physics classes.</td>
<td>3.78</td>
<td>0.41</td>
</tr>
<tr>
<td>2. I do not (do) like new technology during Physics classes.</td>
<td>3.86</td>
<td>0.46</td>
</tr>
<tr>
<td>3. The interactive whiteboard helps me to see how the Physics theorems</td>
<td>3.50</td>
<td>0.41</td>
</tr>
<tr>
<td>4. I concentrate easier during Physics classes if we use an interactive</td>
<td>3.38</td>
<td>0.69</td>
</tr>
<tr>
<td>whiteboard.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I would work harder if I used the interactive whiteboard more often.</td>
<td>3.10</td>
<td>0.82</td>
</tr>
</tbody>
</table>
Table 1 (continued)

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. I know that the interactive whiteboard gives me new opportunities to</td>
<td>3.78</td>
<td>0.41</td>
</tr>
<tr>
<td>learn new things.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. I understand better the lessons when the interactive whiteboard is</td>
<td>3.50</td>
<td>0.60</td>
</tr>
<tr>
<td>used.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I can learn new things using an interactive whiteboard.</td>
<td>3.62</td>
<td>0.66</td>
</tr>
<tr>
<td>9. I feel comfortable using an interactive whiteboard during Physics</td>
<td>3.37</td>
<td>0.71</td>
</tr>
<tr>
<td>classes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. I think it is difficult (not difficult) for me to learn using an</td>
<td>3.76</td>
<td>0.62</td>
</tr>
<tr>
<td>interactive whiteboard.*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. I can add or use new concepts when I deal with conceptual maps and</td>
<td>3.60</td>
<td>0.60</td>
</tr>
<tr>
<td>the interactive whiteboard.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. The lessons where the interactive whiteboard is used really appeal to</td>
<td>3.50</td>
<td>0.41</td>
</tr>
<tr>
<td>me.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. The interactive whiteboard helps me to have a logical and imaginative</td>
<td>3.45</td>
<td>0.70</td>
</tr>
<tr>
<td>thinking.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. I am more interested in the Physics classes when an interactive</td>
<td>3.60</td>
<td>0.55</td>
</tr>
<tr>
<td>whiteboard is used.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. I prefer that the teacher explain the lessons using an interactive</td>
<td>3.62</td>
<td>0.58</td>
</tr>
<tr>
<td>whiteboard.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Averages</td>
<td>3.56</td>
<td>0.575</td>
</tr>
</tbody>
</table>

*The scoring scale for questions 2 and 10 was reversed.

The average for all twenty questions and for all students was 3.56 or midway between “agree” and “strongly agree”. An average value lesser (3.10) than the average for all questions (3.56) was obtained for question 5.

Indeed, the interactive whiteboard can’t be used at every physics class, as the students would like. Scores higher than the average mark of 3.56 were obtained at questions number 1 and number 6 (3.78). The students have the possibility to interact with the interactive whiteboard every time when they start a new lesson or a new chapter.

By using the interactive software, the Internet, the educational movies from YouTube and the interactive simulations from Notebook 10’s gallery, the students have the possibility to see the practical utility of the recently learned notions. The interactive whiteboard allows an interdisciplinary approach of the subjects from the school schedule.

4. CONCLUSIONS

The results of this study, which will be continued, indicate that interactive whiteboards can be used in the classrooms for teaching Physics in order to increase the students’ engagement for the learning process. The students realize the advantages of this new technology and the fact that is necessary to do some efforts in order to become familiar with it.
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