Abstract: Adapting the teaching of physics to students’ learning styles (auditory, visual, and kinesthetic) is improved by using the computer and the SMART whiteboard, who allow showing the specific materials of these types of learning and helps to increase students’ interest for the lesson. Using of ICT, offers to students: resume, reviewing movies containing real experiments, virtual experiments, the simulations, texts, demonstrations. All these opportunities provide an increased quality of education only if they are integrated into a class project, designed taking into account students capacities for understanding, learning, age-specific memory. Benefits of ICT integration in teaching physics are discussed in this article.

Keywords: ICT, teaching physics, cognitive load theory, interactive whiteboard, student’s learning styles.

I. INTRODUCTION

We are experiencing a true computerized avalanche. The extent to which information is produced, collected, processed and transmitted has grown exponentially. If we add to all of these the symbiosis between computer and telecommunications, the communication is absorbed by a computerized society. Computerized systems are nowadays subjected to important technological changes and it seems that this is just the beginning. In this globalised and powerfully computerized world, the educational system must adapt to the new requirements and has to be profoundly transformed. The didactic experience has proved that, as far as the education is concerned, several things are important:

- Efficient interpersonal and team communication;
- The rigour and promptness of information: ICT.

Education has an essential role in the economic growth and European competitiveness. Pupils are part of a teaching community governed by rules, with communication means which must be permanently adapted to a dynamic computerized context.

The traditional learning system offers students a great amount of academic information and applications, but not enough motivation to learn Physics, since it is based on the presentation of facts and not on students’ needs.

In the process of acquiring knowledge as a main activity, the teaching method is focused on teachers and their style of presentation and involves little active learning, and therefore, students are only spectators.

In order to motivate students, teaching methods must be focused on students. Information being itself an essential resource, the way in which it is managed in society has a vital importance for the entire social organism.
ICT can be an instrument to revolutionize the learning process, allowing activities focused on students.

II. PRESENTING, ORGANIZING AND INTEGRATING INFORMATION INTO THE MEMORY

According to the model proposed by Atkinson and Shiffrin, in [1], the human mind architecture contains three registers: the sensitive memory, the short-term memory or the working-memory and the long-term memory.

Mayer [2] and Paivio [3] believe that when processing information three stages are distinguished: presenting information, processing it and integrating it into the long-term memory.

The information is presented to the learner, selected by him and stocked into the sensitive memory. Processing the information in the working-memory is the next stage [4].

The working memory is limited both as volume and as duration when new information is processed. According to Miller [5], the working-memory can process 7(+/2) items of information. In order to enlarge the capacity of the working-memory, the information is organized as cognitive structures or schemas, which are then automated [4].

If the information items are grouped in a proper way, they can be easily memorized [6]. The schemas are then integrated into the long-term memory, which has an unlimited capacity. When introduced into the long-term memory, a schema, seen as a single concept, occupies only one chunk of information [7].

The schemas theory can explain very well the difference between an expert and a novice. While the expert’s knowledge is organized into dense conceptual links, showing profound understanding of the subject, the novice’s knowledge is divided [8]. After practicing for a while, certain categories of information can become automated, this enabling their being processed without a conscious effort [9]. Research shows that in the learning process, the role of the working and long-term memory, as well as the link between them, are essential [10].

In the traditional learning system, the amount of the material which is presented is much larger than the processing capacity of a person. This is why each teacher should take into account the cognitive load theory and its implications and to organize the material to be presented in a manner which would not overload the pupils’ working-memory [11]. Teachers must show pupils how to create their own schemas and how to use the ones they already have in the long-term memory [7]. In this way, pupils will be able to become experts in a certain field [11].

A series of effects of this theory has been emphasized in direct relation with learning.

1.1 Modality effect

When a material is presented to students under visual and acoustic form, the results are much better than in the situation when the same material is presented only under written form [12].

This effect can be explained on the basis of the dual channel hypothesis which implies that the acoustic and visual materials are processed in two different subsystems of the working memory [13]. Through these types of material presentations, the student has the possibility to use both channels (visual and acoustic), thus an extension of the working-memory capacity being created [14]. For example, it is better to give oral explanations than written ones when presenting a chart or a scheme [15].

1.2 Split-attention effect

This effect is produced when several separated visual information sources must be integrated in order to realize understanding. For instance, if the rubric of a problem is on a page, and its drawing is on another one, the student has to split his/her attention between the two sources in order to mentally integrate them. The mental integration requires resources in the working-memory [16].
III. ICT AND COGNITIVE LOAD THEORY

The teaching materials which are based on the cognitive load theory have the capacity to increase learning [8].

When the student has to fulfill a learning task, his cognitive load can be caused by the intrinsic nature of the task or by the way in which the information linked to the task is presented [17]. Three types of cognitive loads are distinguished: the intrinsic cognitive load which is determined by the number of elements from a task and the interactivity grade between them, extraneous cognitive load - is determined by activities and information which do not contribute to the learning process and the germane cognitive load which is related to the construction and automation of the schemas in the working-memory and contributes to the learning process [18]. Nowadays, the youth is growing up with new technology, being considered “digital natives” [19]. This is why, today more than ever, teachers must learn how to adapt to each student’s style [19].

The cognitive load theory suggests that learning is better done when the teaching material is aligned to the human cognitive architecture [8].

The integration of ICT in the learning and teaching process ensures the opportunity for students to use the new technology in order to intensify learning.

It is necessary to computerize the Physics laboratories so that students would be prepared for a changing socio-professional environment. In this way, their permanent access to modern sources of education would be ensured, by this favoring the access on the labor market in an economy based on knowledge.

Computers and ICT have become present in the majority of the learning institutions. The presentation of information is possible with the help of computers in a variety of ways: graphics, pictures, videos, animations etc. According to Mayer’s and Moreno’s studies [20], the multimedia environments have the capacity to promote significant learning. Mayer develops a multimedia theory of learning based on the dual-channel theory [13], the cognitive load theory and the constructive learning theory [20]. In the learning process, relevant information must be selected and organized and then integrated into the students’ existing knowledge.

During Physics classes, interactive simulations can be used. These are easy to use and have a great didactic power. They offer students visual representations of phenomena which cannot be directly observed, such as the movement of photons, electrons etc [11].

The simulations found in PHET (http://phet.colorado.edu/en/simulation) are free and thanks to the Internet they can be used during Physics classes [21].

The simulations contribute to the students’ involvement ensuring a dynamic feedback. The student has the possibility to modify different parameters and to observe what the effect of this intervention is [21]. Interactive models save time when the teacher is preparing the lesson [22]. It has been noticed that a real experiment has been easier to be made after an interactive simulation [23]. The student gets involved due to the simulations which use interaction and visualization so that he or she builds mental models [21]. One will build an environment in which he will be able to fully grasp the phenomenon. For example, using the “Movement of the projectile” simulation from the PHET Project, the student can study vertical, diagonal and horizontal throw as it shown in Figures 1, 2 and 3. Learners can, at the same time, calculate certain parameters for different conditions of the experiment.

When the information is presented using both the visual and the acoustic channel, the capacity of the working memory can be extended [20].

Presenting the information in a manner which uses the already existing organizational structures (schemas) or makes the student organize the knowledge, helps him or her store the notions in the long-term memory [8].
The student’s involvement seems to help activate the knowledge schemas into the long-term memory and create new schemas into the working-memory [24].

ICT allows making computer-assisted experiments. During a computer-assisted experiment, students have the possibility to observe in real time the evolution of a Physical quantity. After analyzing the data from a computer screen or interactive whiteboard, the student has the possibility to better understand the phenomenon. Thanks to such experiments, a large number of data can be processed. Also, the students can process themselves the data obtained; they can create graphics either directly or indirectly using software such as SciDAVIS and then present them on the interactive whiteboard.
Along with rich graphics representations, ICT can also contribute to the organization of information during collaborative learning. The complex information chunks from the task and the cognitive load can be divided in several cognitive loads if there is communication and coordination between team members [17]. Collaborative learning is essential for creating concept maps. Edraw Max and Smart Ideas 5 are only two examples of software to be used when creating concept maps. The fact that a student from a computer-science class can learn how to use new software more easily than one from a language-honors class is noteworthy. A student in a computer-science class has already acquired long-term memory schemas while a beginner has to build them himself. Concept maps can be presented and commented on the interactive whiteboard. In order to create concept maps, students have the possibility to use several information sources available on the Internet. Figure 4 shows “The Levers” concept map.

Using both images and words is more efficient than just words [25].

Multimedia learning is efficient if it is controlled by the student and if he or she can use what he has absorbed in new situations [16].
The involvement of the students seems to help in activating the knowledge schemas and in the creation of the new ones.

ICT makes the efficient use of the interactive whiteboard possible [26, 27]. When a material is created and presented on the Smart whiteboard, it is necessary to take the split-attention effect into consideration. Therefore, Figure 5 shows the role of a lens when treating myopia. The student understands much better when both representations are integrated in one format. The interactive whiteboard is the environment which allows learning in many registers (visual, acoustic). There can be used didactic films to emphasise practical applications of different phenomena such as: the application of the total light reflection in the way an endoscope is built and works, the role of X-rays in computerised tomography.

The interactive whiteboard allows an interdisciplinary approach of learning activities. In this way, students have the possibility to gain a durable and meaningful learning, the acquired abilities being available for transfer outside classes, into the daily life [28].

![Figure 5. Presenting myopia on the interactive board](image)

IV. CONCLUSIONS

In this paper we have tried to describe how ICT can be used during Physics classes, in a way that values opportunities offered by advanced technology, according to the cognitive load theory.

The utilization of the computer while teaching Physics leads to developing new activities which allow the student to acquire new abilities according to his/her own interest [22]. Both students and teachers show a positive attitude towards the introduction of new technology.

What is most important than the use of the advanced technology is the professional preparation of the teacher [30].
Regarding the situation as digital emigrants [19], we can affirm that teachers’ activity area must be modified significantly, so that school can provide a free space for the youth to show their value, thus attaining school performance.

References