A STUDY OF THE PICTORIAL REPRESENTATIONS OF THE PHENOMENON OF FRICTION ON THE INTERNET

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ABSTRACT
The aim of this work is to study the ways in which a natural phenomenon of daily life, such as friction, is depicted on the Internet,. The Internet, apart from being an important source of information, can be developed so that it constitutes a basic supporting element of students in their efforts to build knowledge. In our work the way of depiction of daily life phenomena on the Internet is investigated. To be more specific applets that were located in the Internet, with regard to friction are analysed, evaluated and categorized with these criteria: the choice of using realism or abstraction in the depiction of phenomenon of friction, the relation of phenomenon to daily life, the originality of depiction found in school textbooks, the variety of ways in which the relevant information is visually presented, as well as the possibilities provided for an interaction between students and these applets.
The findings of this present research are limited to a the small number of applets referring to the phenomenon of friction found on the Internet, the adherence in forms of depiction that are met in the traditional school textbooks, the limited use of realistic elements, as well as the low level of the provided interaction with the user.

KEYWORDS
Pictorial representation, applet, science, friction

INTRODUCTION

Nowadays almost any member of the educational community accepts that Internet is an important source of information, which, provided that it is developed suitably, can constitute a structural element of support of students to build knowledge. Until recently, a printed text had the information presented in a concretely morphological way. Today, digital information is diffused henceforth via the electronic networks and is today rendered progressively the more important asset in the new world communication environment.

But, while initially the main concern of science education was the access to the information, today the main objectives of education are:

a. the effective management of information, and
b. the elaboration and evaluation of the enormous volume of information that submerges us via the electronic forms of communication.

In the bibliography, important efforts of researchers in the effective exploitation of possibilities of Internet have been recorded (Linn 2000). According to Linn (2000): ‘The Internet provides contradictory, biased, and up-to-date scientific information that we draw on in the Web-based Integrated Science Environment (WISE) to create activities that can be readily by schools, districts, and countries’ and ‘…we can build on each others' expertise to create customizable materials. Finally, we can pool our expertise in solving problems such as bridging the digital divide and developing a global community prepared to deal with complex science policy issues».

In the present work, we investigate the various forms of applets found on the Internet, which refer to the phenomenon of friction. Especially, our interest is focused on the pictorial representations of the phenomenon. Our main concern is to trace innovative ways of depicting the relative phenomenon, apart from the ones found in science textbooks. Our final aim is to suggest effective ways of using them in physics classrooms.

PICTORIAL REPRESENTATIONS AND EDUCATION

Applets are based decisively on pictorial representations. However, these representations should not be taken for granted in education. An issue that is often raised in the educational community is the investigation of the prerequisites under which picture can help the student to understand, that is to say to achieve their instructive goal. According to Pinto (Pinto 2002) «the comprehension of incorporation or usage reasons of picture for a concept requires knowledge from different fields, such as communication, semiotics theories and scientific disciplines».

The engagement of pictorial messages is based mainly on their resemblance relations with reality. The intellectual elaboration of a pictorial message usually requires less effort than the effort that is required the corresponding of a verbal message, because the verbal message is based on linguistic signs, in which the relation of sound (signifier) and meaning (signified) is "arbitrary". Consequently, the picture, or the "proportional" relation (signifier - signified) usually requires simpler intellectual activity. In cases of pictures that are not found in proportional relation to the “real” object which they represent, it is essential to educate their receiver in the reading of meaning (signified). Thus, the "visual education" of students is considered to be necessary for the appropriate «reading» of the relative pictures.

APPLETS AND SCIENCE

Nowadays, applets are developed rapidly, because they are considered to be flexible and powerful educational tools. It is foreseen that they can function either in co-operative learning, or in individual learning. This is particularly important, because as many researchers have pointed out, learning becomes more effective when the trainee has the control of its training process, participates actively in the construction of knowledge and has the possibility of dialectic communication in a co-operative learning environment (Resta, 1998, Ryan and Woodward, 1998, Seffah and Bouchard, 1998, Carvin, 1997, Goetter and Kazamek, 1990).

The advantages that are reported for applets are the following:
Applets:

- are small in size, can be removed easily and run with most operating systems;
- allow the pictorial implementation of experiments in science or the depiction of representations of microcosm and macrocosm;
- provide the possibility of repetition, at any time and in any place (in the house, in the school, in the Internet Cafe);
- encourage exploratory learning;
- have (generally) steady (constant) addresses on the Internet for a sufficient length of time, because they are usually created in Academic network places; also,
- the access to these applications is almost always free, via the Internet.

It is essential for students to learn how to handle this dynamic tool, either by watching visual experiments, simulations and experimental devices or by implementing visual experiments, thus remaining constantly active users and not passive recipients. This is achieved if the specific applet motivates students to justify and explain the presented material. Simultaneously, a good school practice should provide a number of activities/worksheets to students, aiming at their active attendance. Students following worksheet instructions are intended to be able to observe, formulate assumptions, record measurements and data, analyse the provided information, and infer conclusions. Also, they are intended of being able to understand the symbolism used in the representations of applets, so that they can draw conclusions.

It should be point out that the input of applets in the educational process does not decrease the traditionally well working means in teaching. Applets supplement these means creatively. It is important to remember that such applications are recommended in on screen symbolic object management. Consequently, their integration in the educational process should be done in combination with the experiments in the laboratory (hands-on or MBL) and other conventional visual aids.

APPLETS' EVALUATION CRITERIA

The criteria, with which an applet application is selected and evaluated, resemble the criteria used in educational software evaluation only. These criteria refer to:

Technical characteristics

- The stability and the reliability of application, so that undesirable side effects are avoided, (such as the freezing of the PC or the restart of application etc.).
- The possibility of position finding, removing or installing an application.

Educational characteristics

- The content: the kind of issues presented, the ways the scientific knowledge is presented, the ways the transformation of scientific knowledge into school knowledge is achieved, the kind of images used, etc.
- The usability: the application's facility in school practice, its easiness in navigation, and the way the organisation of the information is presented.
- The compatibility with the school science curriculum: the possible ways of adapting the application to the aims of a subject of the science curriculum and the investigation of whether it can serve the corresponding instructive objectives.
- The covering of special needs in science education: the necessity for simulations of experiments for which there are problems of safety, lack of instruments and necessary material; or the necessity of visualisation of phenomena which cannot be observed in the laboratory (e.g. phenomena of microkosmos or megacosmos).

Technical and Educational characteristics

- The interaction between user-application.
- The possibility of synchronous multiple representations of physical phenomena or of science concepts, according to the didactics of science.

RESEARCH METHODOLOGY

This study was implemented in two time periods. Thus, we had the opportunity to assess more precisely the results found on the Internet, in which new sites open daily and at the same time some others for various reasons close down. The first phase of the study involves the period April-June 2002 and the second phase the period August-November 2002.

The effort to locate sites that are related to friction produced very limited results. (In the course of our research, we excluded applications found in programs such as Interactive Physics and Modellus.

The main characteristic of those applets found, are: a) the conservative ways of depiction and b) the small number of sites related to friction phenomenon, which meet the general evaluation criteria for all applets.

These applets were analysed and studied upon the following criteria:

- Ways of depiction: the investigation of the ways the visual representation of friction in various sites is attempted (e.g., the use of mathematics, abstractive diagrams, realistic depiction, use of symbols, etc).
- Ways of multimodal representation: how the phenomenon of friction is depicted in the same site (presented in the same depiction in more than one ways).
- The use of realistic or abstracted elements in the way friction is depicted: whether the phenomenon is depicted with reference to everyday life or is represented as isolated from the environment in which it is naturally occurs.
- Possibilities offered for an interaction between application and the student: Investigation of the proposed ways of interaction with students

RESULTS

The analysis of the applets according to these criteria led to the following results:

Ways of depiction

A peculiar characteristic found is that the ways friction is depicted on the Internet are limited and influenced by the way it used to be represented in the traditional school textbooks. Thus, although friction is a common phenomenon of everyday life, we could not trace innovative ways of representing it. Instead, the way the phenomenon is depicted and the communication codes used in this depiction, refer to pictures and to practices that either are used in traditional textbooks or in the traditional way of teaching. Maybe, this is due to the fact that friction is one of the oldest physics phenomena presented in physics textbooks and people used to take for granted the way of its depiction.

Thus, in nine (9) out of eleven (11) applets found, the way friction is depicted, is influenced by the way the phenomenon has traditionally been represented in physics textbooks for many years. The only difference traced, is the possibility of presenting the actual development of the phenomenon, as well as the possibility of changing the parameters, which determine the relevant phenomenon. Thus, the ways of depiction and communication are the followings:

- The kind of representation of a body's movement (by using either abstractive or more realistic elements);
- The use of graphs (for example time-displacement graph);
- The quantitative or qualitative study of the phenomenon;
- The use of mathematical formalism;
- The use of symbols (for example vectors, arrows etc.)

Ways of multimodal representation

We examined the number and the ways of simultaneous visual representation of the phenomenon traced in each application. For example, in one case the following ways of depiction are found: representation of movement of the body, depiction of forces with the use of symbols and a matrix. From the applets found, five (5) of them use simultaneously three ways of depiction (Representation of body's movement, use of symbols and a quantitative study of the phenomenon), while the others use two ways or one.

Use of realistic or abstracted elements (Reference to everyday life)

Of all applets found on the Internet, only two (2) out of eleven (11) were using realistic elements with low degree of abstraction. As a result, only these applets aimed to simulate scenes of everyday life. The visual elements used are mainly realistic sketches of a car, of a street- light or of a billiard game. For example, the application 1 (followed) is lacking in realistic elements, contrary to the application 2 (followed) which is supported by the realism of the representation.

Potentiality of interaction between the application and the student

In the applets studied, the possibility of interaction between application-student is usually limited, only allowing the change of some of the parameters of the phenomenon of friction. Given that the educators consider that the possibility of interaction allowed in the applets is an important comparative advantage, they have over the textbooks or non-interactive educational material (such as video), it is essential to underline that all the applications found in our research allow only a limited amount of interaction (the possibility of changing only some parameters of the phenomenon of friction). Thus, it seems that the designers of the relevant applets have a limited notion of what an interaction could be, resulting in interactions of limited instructive value.

THE PRESENTATION OF TWO CHARACTERISTICS EXAMPLES

Application 1: Study of accelerating movement of body with friction.

Electronic address (URL): http://home.a-city.de/walter.fendt/physengl/newtons2law.htm

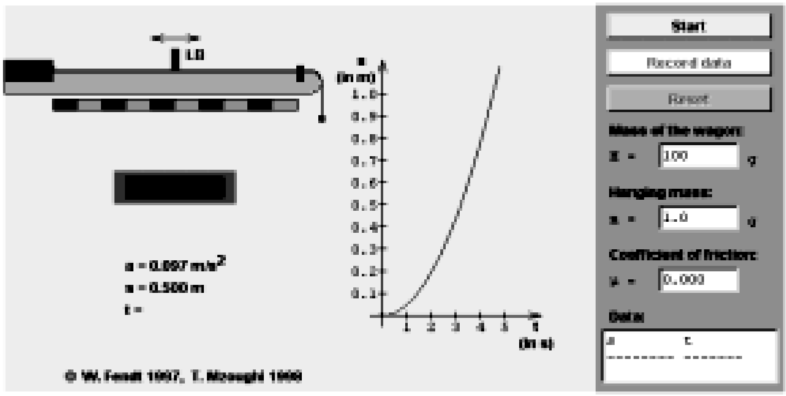

Figure 1. Study of accelerating movement of body with friction

The application (Figure 1) constitutes a unrealistic representation with a high degree of abstraction and lack of realistic visual elements. The depiction is exceptionally minimal, avoids the realism and is focused mainly on features, which the student should note, such as the graph representation, the body's movement and the values of the body's displacement over time. The depiction is multimodal and co-deploys 4 ways of visual representation:

- the abstracted graph (graph of displacement –time);
- the mathematical equations;
- the depiction of the body's movement;
- the table of values (matrix) and results.

The application may be easily adapted to the learning process and is reminiscent of the traditional way of teaching. The students are allowed to change only a small number of parameters of the phenomenon.

Elements motivating students

There are no references to the physical environment in which the phenomenon of friction occurs. That is the reason why the study of this phenomenon in physics classrooms seems meaningless to students.

Interface

The interface is rather simple. The "reading" of the presented picture is not easy for students, because it is highly abstracted. However, the application proceeds quite easily. The use of buttons and the selectivity control are simple too. Over all, students need to make a great effort for the mental processing of the presented physics concepts, especially because the application is based on a mathematical formalism of the phenomenon.

The application is stable and there are no undesirable side effects. There is compatibility with the school science curriculum and the application can serve corresponding instructive objectives.

Application 2: Reaction time

Electronic address (URL): http://www.phy.ntnu.edu.tw/java/Reaction/reactionTime.html

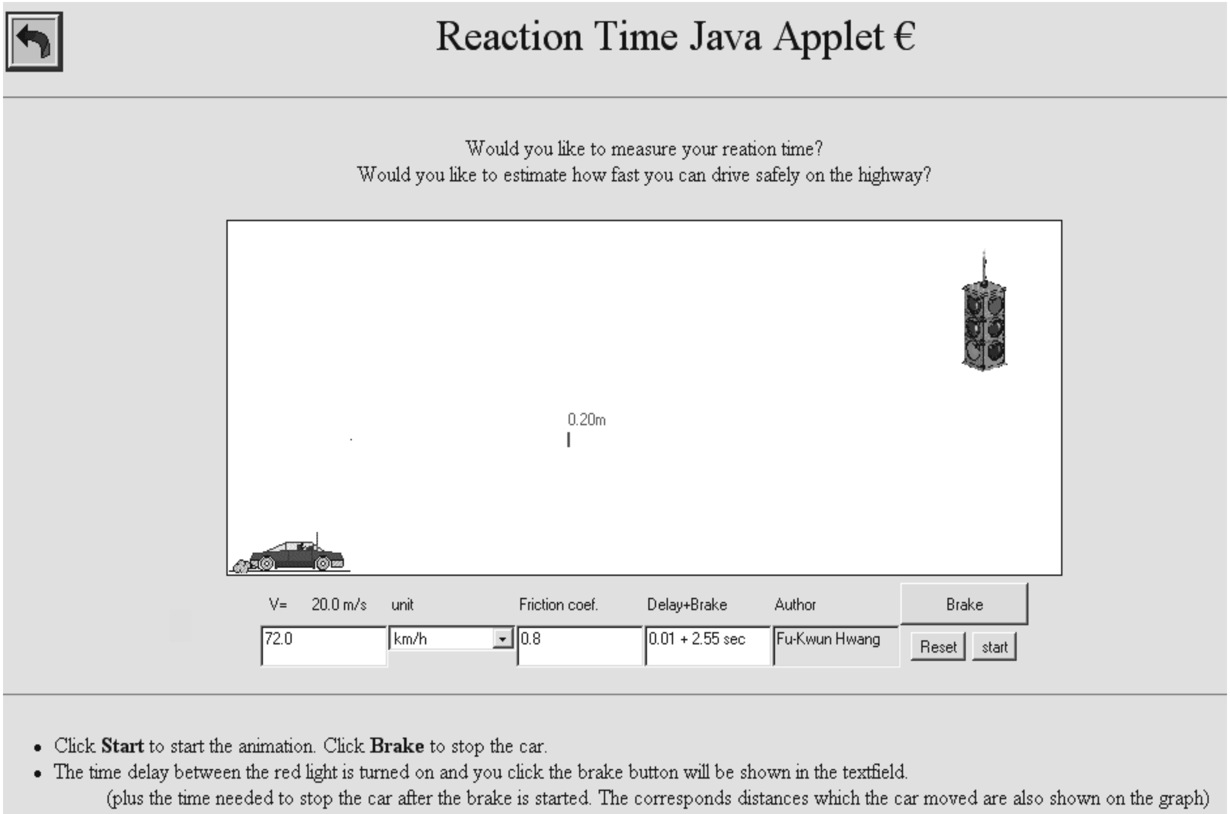

Figure 2. Reaction time

This application (Figure 2) refers to a scene of everyday life, and in order to depict it uses realistic elements with a small degree of abstraction. So, the realistic visual elements used, are a car and the streetlight. Also it allows the use of brake with button. The depiction is minimal from an aesthetic point of view and it is focused mainly on realism of representation and on the observation of the car's movement.

Educationally speaking, the application is focused on the adjustment of values of the initial speed and friction coefficient.

Interface
The application's interface is rather simple. The use of buttons and the selectivity control are relatively simple. Student needs a limited degree of mental processing to "read" the relevant depiction, since is proportionate the presented picture to "reality".

Elements motivating students
The designers of this applet chose to omit the mathematical formalism in the processing of the phenomenon, aiming to motivate students, so that they first grasp the whole picture of the phenomenon portrayed. However, if this application is going to be used in science classrooms, the science teachers may ask for the mathematical elaboration of the phenomenon in addition. This application may easily be adapted to the learning process, because it utilizes realistic elements which constitute a high

motivating element for students. So, it can be used as an introduction to a further elaboration of the phenomenon in physics classrooms.

The application is stable and there are no undesirable side effects. There is compatibility with the school science curriculum and the application can serve corresponding instructive objectives.

CONCLUSIONS

From our study the following conclusions resulted:

1. Despite the fact that the phenomenon of friction is related in many ways to our everyday life, most of the ways of its depiction on the Internet, reproduce the forms of depiction usually met in the traditional textbooks.
2. Most of the applets found do not use realistic elements. Thus, these applications seem meaningless to students, since they cannot perceive the whole phenomenon in a qualitative way. Consequently, students are limited to quantitative calculations only.
3. The interaction between application-student found is limited. The possibility of changing the relevant parameters of the phenomenon and watching the results they cause on screen, seems to aim at helping students to a quick elaboration of the exercises found in traditional textbooks.
4. The number of applications met is disproportionately small in relation to:
   a. the presentation of an everyday life phenomenon;
   b. the multiple ways of depiction of the studied science concepts.

Consequently, it appears that the visual presentations of the phenomenon of friction found on the Internet do not present innovative and radical solutions for its didactic utilization in science classrooms. Students prefer to study subjects that seem meaningful to them, that is to say concepts that are of use in their everyday life.

Thus, for further use in science classrooms we suggest a combined use of:

- applets that are realistic representations of the friction phenomenon allowing its qualitative study. In this way, students are motivated to correspond the result of their study to their daily life experience, and
- applets that represent the phenomenon in an abstractive way, thus allowing its quantitative study.

This proposed combined use of applets permits students to focus on the critical components influencing the study of the phenomenon.

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