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Real Time Control Learning Game - Speed Race by Learning at the Wheel - Development of Data Acquisition System

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***Abstract*—**Schools today face ever-increasing demands in their attempts to ensure that students are well equipped to enter the workforce and navigate a complex world. Research indicates that computer technology can help support learning, implementation of various experiments or learning games, and that it is especially useful in developing the higher-order skills of critical thinking, observation, comprehension, implementation, comparison, analysis and active attention to activities such as research, field work, simulations and scientific inquiry. The ICT in education supports the learning procedure by enabling it to be more flexible and effective, create a rich and attractive training environment and equip the students with knowledge and potential useful for the competitive social environment in which they live. This paper presents the design, the development, and the results of the evaluation analysis of an interactive educational game which using real electric vehicles - toys (material) on a toy race track. When the game starts each student selects a specific vehicle toy. Then students are answering questionnaires in the computer. The vehicles' speed is related to the percentage of right answers in a multiple choice questionnaire (software). Every question has its own significant value depending of the different level of questionnaire. Via the developed software, each right or wrong answers in questionnaire increase or decrease the real time speed of their vehicle toys. Moreover the rate of vehicle's speed increase or decrease depends on the difficulty level of each question. The aim of the work is to attract the student's interest in a learning process and also to improve their scores. The developed real time game was tested using independent populations of students of age groups: 8-10, 11-14, 15-18 years. Standard educational and statistical analysis tools were used for the evaluation analysis of the game. Results reveal that students using the developed real time control game scored much higher (60%) than students using a traditional simulation game on the same questionnaire. Results further indicate that student's interest in repeating the developed real time control gaming was far higher (70%) than the interest of students using a traditional simulation game.

***Keywords*—**Real time game, sensor, learning games, LabVIEW

I. Introduction

AMONG the most important features that characterize a successful learning environment are the dynamic role that a student is invited to play within it, the opportunity for action from different points of view, the independence of activities with intrinsic goals and incentives, students' freedom of action, the application of their own logical decisions and the interaction of the environment with the student, immediate feedback and the possibility of assessing individual progress [1]. A simple presentation of events, their understanding and rote-learning of rules does not constitute a sufficient condition for learning. What needs to be developed is a positive stance towards the learning process, research and problem-solving. Educational games appear to offer the opportunity to support this desire to learn. The continuing desire to learn is supported by factors such as curiosity, competition and imitating a role model [2], [3]. To these may be added the interest that children show in playing, which contributes to their concentrating on the educational activity. Although there are no clear criteria enabling us to distinguish educational material generally from an educational game more specifically [4], we can summarize the characteristics of educational games as follows [5]:

- Learning goals: educational games are designed for a specific goal and aim at the achievement of a specific goal.
- Totality of rules: there must be a clearly defined totality of rules in order to facilitate the player's interaction with the game.
- Interactivity, active role of player: Without the active participation of the players in the game, the concept of play may not be said to exist.
- Feedback: the game must reward a correct decision and punish a mistaken one. In this way, the players will be able to distinguish successful from unsuccessful actions and concentrate on their goal.
- Competition: competition can be inherent between co-players or between player and computer, in order for a goal to be achieved or a high score to be made.
- Element of challenge: the element of challenge relates to uncertainty as to whether the goal will be attained, hidden information and multiple levels of difficulty.
- Element of entertainment and motivation [6]: the very idea of taking part in a game appears to attract children and entertain them as much as achieving the goal of the game.
- Pre-existing knowledge: an educational game also presupposes some knowledge in a field, for example mathematics or language [7].

A further feature of games, which appears to support their educational dimension, is that they produce a feeling of satisfaction: namely that the educational activity presented in this way constitutes by itself a reward for the student just as much as achieving the goal does [2], [8]. According to research [9], the chief characteristics which result in games being attractive may be divided into the following categories:
personal incentives, such as curiosity, challenge, imagination

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and the control which the player exercises, and interpersonal incentives, such as cooperation, competition and recognition.

Other characteristics which make games attractive are action, dramatic interest, collisions, uncertainty regarding the outcome, the challenge to achieve the goal, the element of fantasy and magic, the variety of presentations and renewal, complexity to an appropriate degree, surprise [10]-[11], and the dynamic visual imagery presented [12]. From research carried out into the preferences of the children themselves [13], it appeared that the most popular characteristics were the score, optical-acoustic effects, the degree of readiness required from the players and the existence of one specific and predetermined goal. Ultimately, an educational game cannot be regarded as successful if it fails to hold the interest of the pupils until the achievement of the goal and the confirmation of learning. The player's satisfaction is stimulated by the very activity of being involved in the game, the achievement of the goals set within it [10] and completing the game itself. There are also cases in which the children go beyond the goals set by the game and aim at goals of their own such as a higher score. Generally speaking, however, the goal of a successful educational game should not be to produce a winner but rather to reinforce certain behaviors and strategies.

A further important characteristic of educational games is the opportunity for immediate feedback on actions and on the progress of the student [14]. The immediate connection between action and result reinforces its educational consequences [15]. Feedback should include the element of pleasant surprise and at the same time be constructive [10]. Finally, games may provide dynamic support, through a gradual increase in the degree of difficulty [16]. In the present paper the development of a game which includes a material and software aspect will be presented. The chief goal of the game is to increase the healthy competition among the students through a different form of assessing their knowledge. A characteristic feature is its interdisciplinary nature, with applications to many types of subjects (chemistry, physics, math's, IT etc).

The developed game contributes to the dynamic development of learning to a greater degree than the use of virtual multimedia and simulations.

II. Materials and Methods

Both hardware and software were designed for the development of the game. The software was developed via LabVIEW programming. A power circuit interface was developed for the motion control of the toy electrical vehicles. Sensors were also placed on the toy race track to determine the vehicles' speed and measure the number of laps they completed.

The material was developed in the Electronics Laboratory of Livadia Senior High School with the support of the students as an application of their knowledge in their field. The units used for the development of the hardware aspect of the game included:

1. Data acquisition module USB 6008 of National Instruments
2. Power interface to control the speed of each vehicle
3. Proximities sensors (Hall effect)
4. Electronic interface for proximities sensors
5. Web camera.
6. A toy race track and electrical vehicles.

The National Instruments Data acquisition module USB 6008 is a data acquisition device (DAQ) in real time which is controlled through the LabVIEW code. Inside the module the code of the developed game sends electrical signals to the vehicles in the race to increase or decrease speed in real time.

A power interface was designed, appropriate for the power requirements of the vehicles. The power interface supplies the vehicles with current at a satisfactory level. In order to record the completed laps of each vehicle a special proximity Hall effect sensor for each vehicle was installed at the starting point of the racetrack. Through a suitable circuit the signal from each sensor gives information in the game code every time a vehicle completes a lap. The use of a web camera permits the race to be broadcast in real time to a distant user, who is able though the software developed to control the speed of his/her vehicle while taking part in a learning race.

Fig. 1 shows the configuration of the hardware used for the development of the game. When the game starts each student selects a toy vehicle. Then students answer questionnaires on the computer. The vehicles' speed is related to the percentage of right answers in a multiple choice questionnaire (software).

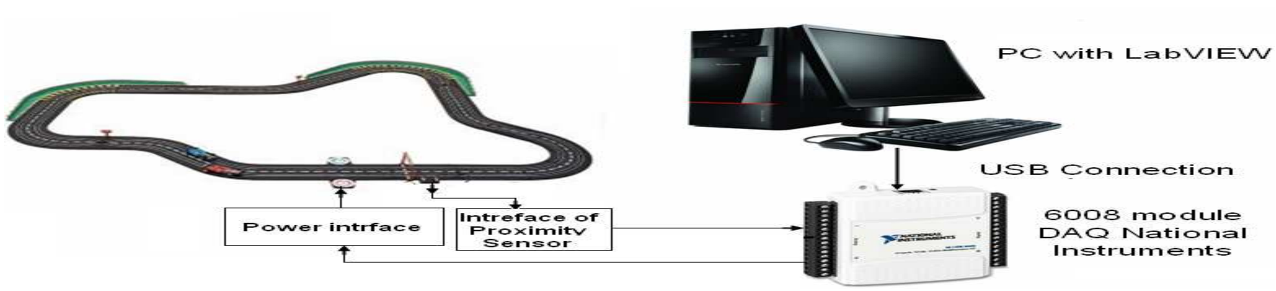

Fig. 1 Output of 6008 module DAQ connected to the control devices of cars. Via LabVIEW programming the degree to which exercises are solved correctly results in the car increasing or decreasing speed in the race. If the student solves all the subsections of an exercise, the car reaches maximum speed

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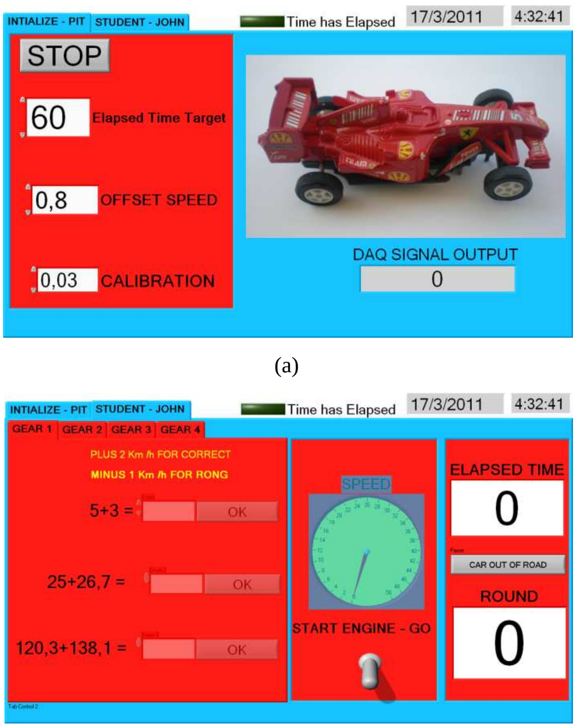
Every question has its own specific value depending of the different level chosen in the questionnaire. Via the developed software, each right or wrong answer in the questionnaire increases or decreases the real time speed of students' toy vehicles. Moreover the rate at which a vehicle's speed increases or decreases depends on the difficulty level of each question.

Fig. 2 presents the front panel of the developed code of the game. Fig. 2a presents the front panel and the calibration of each vehicle before the start of the race. The user determines the maximum time for the race (the time during which the student has to complete the test) as well as technical characteristics for control of the power supply to his/her vehicle. Fig. 2b presents the environment in which the student receives the assessment test for his or her knowledge. In this specific image the test which has been developed concerns the exercise of primary school children in the four basic mathematical operations.

As the student chooses to answer questions on addition (first gear of the vehicle) s/he observes the vehicle gain speed with every correct answer while the speed falls with every mistaken answer. When the student chooses to run the vehicle at a higher speed, for example in fourth gear (level of division) s/he observes that the vehicle develops higher speed in response to each correct answer while the speed drops correspondingly in response to each wrong answer in comparison with first gear addition sums.

Fig. 3 shows the multiple choice method through which the student records the answer at the Gear 4 level of division.



(a)

(b)

Fig. 2 a) front panel of calibration, b) front panel of test (Konstantinos Kalovrektis)

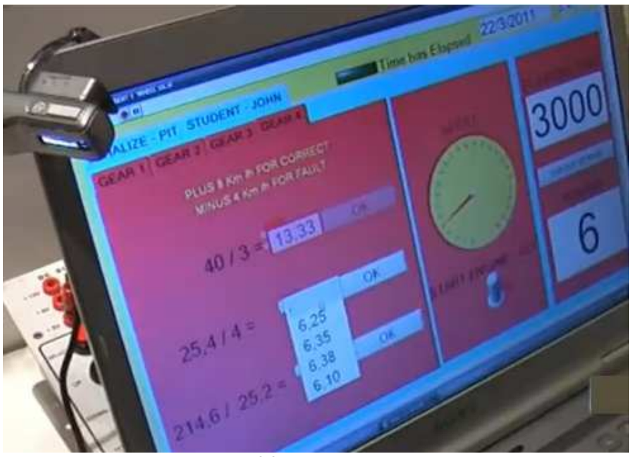


Fig. 3 Screen of front panel in a speed race

A characteristic of the developed software is that the student is unable to change an answer once it has been recorded. The developed software provides the opportunity to apply the game to different subjects by allocating questions to each gear. For example, the software was applied as a learning game for assessing a unit of grammar in the English language. In this case the student driver of each vehicle had to choose appropriate verbs for sentences in each gear. Students even from different countries can perform the test online via internet access, (via the developed software), while they are observing (via a web camera) the movement of their vehicle in a "knowledge race". The special race track for the electric vehicles was developed in the Electronics Laboratory of Livadia Senior High School, Greece. Fig. 4 shows the hardware configuration used for the development of the game via web.

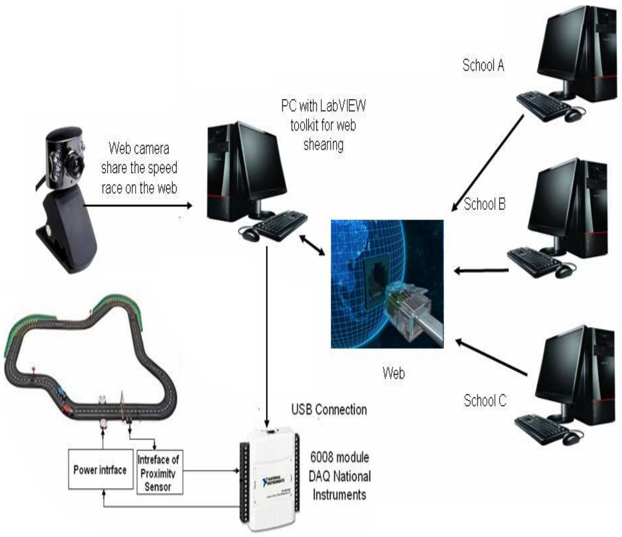


Fig. 4 Model of web race

Fig. 5 shows the image (via web in a real time speed race) on the student's front panel.

Fig. 5 Screen on front panel in a web speed race

In order to assess the developed game in the reinforcement of a learning model through play due to its possible application in a range of subjects and levels of learning, we examined its pedagogical influence on a wide age range of students, 8-10, 11-14, 15-18 years. In each target group we divided the students into two groups of equal numbers. The first groups, which we called ‘Simulation Team’ (ST) received the test through multiple choice software in a simulated race (moving bar) format (excel). The second group, called ‘Real Time Speed’ (RTS) received the test through the developed game. At the end both groups filled out a questionnaire through which information was derived concerning the assessment of the value of the game in comparison with conventional methods of assessment of the effect on learning.

III. Results / Discussions

In the bar chart in figure 6 the results of measurements of the questionnaire are presented.

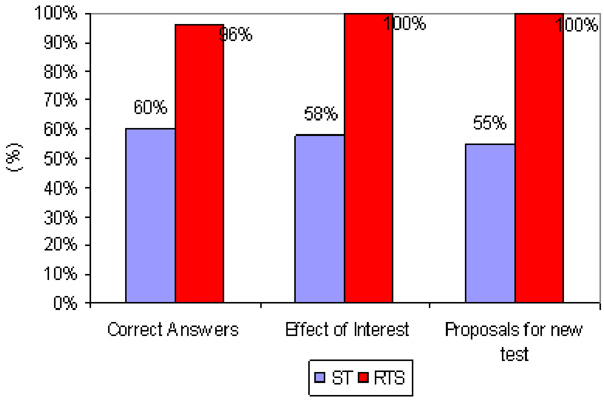


Fig. 6 Bars showing questionnaire results from teams ST and RST

From the above results, the average performance over the total number of answers according to Fig. 7 shows that the students who took part in RST through the game presented a higher learning performance mark (99%) than those in team ST (58%).

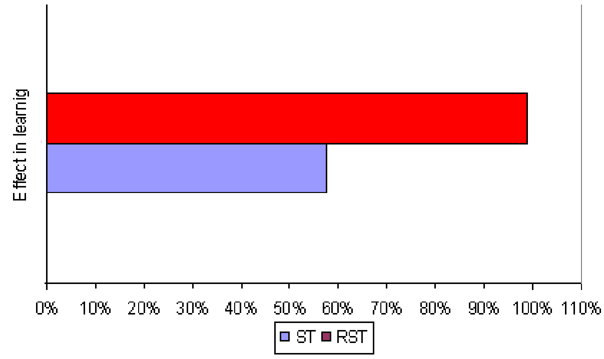


Fig. 7 Average performance in answering questionnaire of teams ST (■) and RST (■)

The bar chart in Fig. 8 shows the results of measuring the test responses to the questionnaire in terms of interest in using the game in comparison with the conventional multiple choice test through software simulation. From the results it may be observed that interest in using the game remains stable in all student age groups, whereas for the multiple choice test through software simulation interest falls in the higher age groups.

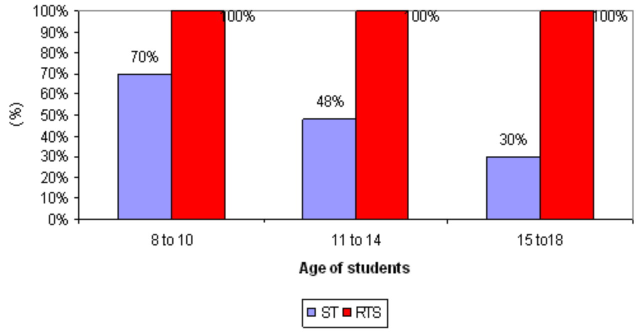


Fig. 8 Effect of interest (■) traditional educational test games, (■) speed race by Learning at the Wheel

IV. Conclusion

From the above results we conclude that the racing game with the student at the wheel:

1. increases the “healthy competition” among the students (... who will finish first!)
2. is interdisciplinary with applications to many types of subject (chemistry, physics, maths, IT etc.)
3. has a positive impact on the learning process
4. the students using the developed real time control game scored much higher (60%) on the same questionnaire than students using a conventional simulation game. The results also indicate that students’ interest repeating developed real time control gaming was far higher (70%) than the interest of students who used a conventional simulation game
5. The use of the computer as a tool (to control the vehicle) gives students the opportunity to become familiar with aspects of its use beyond simple internet research and the virtual dimension.

It is a common misconception that game-based learning is, by its very nature, engaging for the majority of learners. This is not necessarily the case, particularly for learners in Higher Education who may need to be persuaded of the value of learning games. For some learners, games may simply not be perceived as engaging–either in terms of an initial motivation to play or sustained participation [17]. As Kickmeier et all [18] indicated "one of the trump cards of digital educational games is their enormous intrinsic motivational potential. Although learning game design is often understood on a one-fits-all level, the actual motivational strength of an educational game strongly depends on the individual learners, their very specific goals, preferences, abilities, strength and weakness, personality, and experiences with gaming". What we really realized from the implementation of the the developed real time control game and our students' point of view, is that the motivation in the learning process is a fragile and constantly changing state and that the game helps efficiently in that educational goal.

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