

*Full Length Research Paper*

# Interactive multimedia related to real life, a model to teach physics in high school

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Students' understanding of what physics is about, how it is done, and their expectations as to what goes on in a physics course, can play a powerful role in what they get out of learning physics. In this paper with the help of MPEX, we reported on the results of pre and post test in Javan Student Research House, Tehran, Iran. We noted a gap between the expectations of students in experimental group and the control group. During this research experimental group was taught by a mix of approaches (See appendix). This research investigates 'use of knowledge' by multimedia where knowledge is taught in specific contexts taken from life and how effectively students are able to transfer their learning of physics concepts across the differing real-life contexts found in interactive multimedia, and finally on to a non-contextual situation. The plan needs a physics computer software context-based student learning material which provides a self-study program in physics for secondary students to use with the support of their teachers. The research was done for 50 high school students (level 11) in 2 groups, one group as experimental group(new approach teaching) and the other group as control group under traditional teaching, the pre and post test were the same for both of them. Students who were target of this research were very successful and their viewpoints about learning physics improved.

**Keywords:** teaching physics, high school, real life, interactive multimedia, MPEX.

## INTRODUCTION

The idea of study started from discussions with students in classrooms. They uttered the general complaint that too much dominated by mathematics in physics concepts. The response of the teachers was that it is absolutely necessary to have a good understanding of phenomena by mathematics, it is common language of all physicists and many other scientists, and we have learnt

physics with formula. In reality many students will forget formulas after a short time. There is no unique answer to the question: What is the best way to teach a particular subject? Different students will respond positively to different approaches. If we want to adopt the view that we want to teach all our students (or at least as many as possible), then we must use a mix of approaches (Redish, 1994). Results from research indicate that most students in a traditional introductory course cannot do the qualitative reasoning necessary to apply concepts to situations not expressly memorized. Experiences has shown that this ability can be developed if students are

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Given practice in solving qualitative problems and in explaining their reasoning. If students go through the reasoning involved in the development and application of important concepts, they can significantly deepen their understanding of even very difficult material (Heron et al., 2004).

Meaningful learning occurs when a learner selects relevant information, organizes it into coherent representations, makes connections among corresponding representations in each channel (Mayer, 1997), and builds mental representations from the words and pictures. A well-designed educational multimedia presentation incorporates the use of both auditory and visual channels in order to increase the memory input capacity and employs the multimedia design principles (Moreno and Roxana, 1999). For example, educational researchers found that if the verbal explanation or reading is not accompanied by visual representations, students are often unable to remember most of the key ideas or to apply the concepts to similar situations (Carney and Levin, 2002). With multimedia tools, instructors can integrate the power of the visual and the verbal modes of presenting concepts to enhance student learning (Mousavi et al., 1995). Furthermore, students learn more deeply when words are presented in conversational rather than formal style (Mayer, 2001). So we should review learning with methods that they are interesting and practical. Concentrating on the physics phenomena's in the real world and thinking about these phenomena and looking for other kinds of them, using the computer soft ware to create and simulate the same phenomena and growing up the imaginations, could be good methods to improve students' learning in physics. In this study it was decided to grant their wish and set up some sessions with as theme physics of daily life. By touching on phenomena, different parts of physics and the accompanying theory would be discussed with the students. Being exposed to phenomena and open questions and being encouraged to think as a physicist was more important than providing the theoretical background along the traditional lines of the sub disciplines and theories of physics (Mudde, 2008). On the other hand students were overwhelmingly positive about using computers. They enjoyed using this technology and were surprised to know how they might use multimedia to learn physics. In this way, students were given tasks that were relatively simple to complete, while the accompanying assessments questions challenged their prior conceptions. We preferred to try the effects of working with students by multimedia in virtual world to investigate their knowledge about real world in physics concepts. Some researchers examined how successful students are in conventional exams where real world contexts are trivialized and laboratory/school contexts dominate, and compare this with an assessment where context varies but is not trivialized and is real world. In particular, the research investigates how effectively

students are able to transfer their learning of physics concepts across the differing real-life contexts found in interactive multimedia, and finally onto a non-contextual situation (Whitelegg et al., 2002).

Some researches shows the students in the multimedia activities out performed, the students who did not experience the multimedia activities in a final course examination and across identical discussion questions (Sadaghiani, 2012). We considered: What is the relation between instructional contexts with students' expectations, attitudes, and epistemological beliefs about physics and physics learning, in traditional learning and interactive multimedia related to real life?

The steps for teaching strategy are as follows: 1- Pre test exam: reality link cluster of MPEX, 2- Using an interactive multimedia, motivating students to find the relation between physics concepts and real life during teaching process by working on planned worksheets in teams as a group working and peer-instruction. Planning some activities and using them in each session or as their homework. 3- Investigating students understanding in physics concepts related to real life depending on their text book by written exams during research time. 4- Post test exam: reality link cluster of MPEX at the end of the semester. This paper first provides a brief description of the reality cluster of MPEX tool to measure students expectation related to real life physics concepts. Then, it discusses the study regarding the effectiveness of multimedia related to real life in enhancing the learning of students enrolled in high school (level 11), in Javan Student Research House (JSRH), Tehran, Iran. Finally tries to show the students expectation comparing traditional and interactive multimedia instruction method.

## METHOD

To improve project we decided to try multimedia facilities related to daily life.

The study was carried out in a second semester introductory physics course focused on thermodynamics and electricity and magnetism concepts. They were selected by virtue of being the students in Javan Student Research House (JSRH), where the researcher worked as a teacher assistant. The research was done for 50 female students (level 11) in 2 groups, one group as an experimental group (under multimedia related to real life method) and the other group were taught in traditional method. Traditional classes consisted of lecture and recitation sections. Students in traditional physics classes had no computer based learning sections and the pre and post test were the same for both of groups. An assumption built into the material is that it is more important for the students to learn a few topics deeply and to build a sense of how the methods of science lead to "sense-making" about the physical world than to cover a large number of topics superficially. The worksheets

were based on research in student understanding. The worksheets guided the students through observing physical phenomena, constructing hypotheses to explain the phenomena. Instructor helped students to find their own path to understanding by guiding them with carefully chosen questions.

The project aims to motivate students to learn by increasing their interest in physics in everyday life. It includes some questions about observations, and then finding the concepts related to physics in environment. At the end, looking for concepts explanation through web pages and self-learning. There is an interactive multimedia which is designed for students to get along with and do researches about physics concepts in life. In many cases the observation seems trivial, but the answer can push them deeper and deeper into the world of physics. This allows students to further build up their knowledge about phenomena. Finally they had to prepare an essay in which they discussed a topic they had chosen themselves from the physics of daily life in a multimedia. Moreover, they had to write a physics essay about their findings. One of these online software which we focused on it, is accessible in the website: [http://www.physics.org/interact/physics-life/web/physics\\_life/](http://www.physics.org/interact/physics-life/web/physics_life/)

It includes the physics life cartoons, which are around us in our everyday lives as follows: night, day, car factory, office, house, playground, school, street. This interactive multimedia uses synchronized animations and narrations to increase memory input capacity, present three-dimensional dynamic images to help learners build appropriate mental representations, and make clear connections among key ideas to help learners organize concepts while avoiding unnecessary text and images to reduce student cognitive load.

The steps for teaching are as follows: 1- Pre test exam about reality link cluster of MPEX (to determine their expectations, attitudes, and epistemological beliefs about physics and physics learning.), 2- Using an interactive multimedia, motivating students to find the relation between Physics concepts and real life during teaching process by working on planned worksheets in teams as a group working and peer instruction. Planning some activities and using them in each session or as their homework. 3- Investigating students understanding in Physics concepts related to real life depending on their text book by written exams during research time. 4- Post test exam reality link cluster of MPEX at the end of the semester. This research investigates how effectively students are able to transfer their learning of physics concepts across the differing real-life contexts found in the interactive multimedia. Learning is context dependent but context-based learning is a complex phenomena and it could be supported by this method. This has led to the same physics concepts being taught in more than one unit, but in different real-life contexts.

## MPEX tool

Students' understanding of what physics is about, how it is done, and their expectations as to what goes on in a physics course, can play a powerful role in what they get out of learning physics. Maryland Physics Expectations survey (MPEX); is a 34-item Likert-scale (agree–disagree) survey that probes student attitudes, beliefs, and assumptions about physics. In the Maryland Physics Expectations (MPEX) project, the Physics Education Research Group has been investigating the distribution of student expectations at the beginning of the course, the effect of their expectations on their behavior during the course, and the effect of the course on changing their expectations. Particular problems lie in the areas of relation of physics to reality and applying appropriate effort.

The survey was constructed to illuminate student attitudes along five specific dimensions, and includes questions. The survey items are included as, Independence: beliefs about learning physics, whether it means receiving information or involves an active process of reconstructing one's own understanding; Coherence: beliefs about the structure of physics knowledge, as a collection of isolated pieces or as a single coherent system; Concepts: beliefs about the content of physics knowledge as formulas or as concepts that underlie the formulas. Reality Link: beliefs about the connection between physics and reality, whether physics is unrelated to experiences outside the classroom or whether it is useful to think about them together; Math Link: beliefs about the role of mathematics in learning physics, whether the mathematical formalism is just used to calculate numbers or is used as a way of representing information about physical phenomena; Effort: beliefs about the kind of activities and work necessary to make sense out of physics, whether they expect to think carefully and evaluate what they are doing based on available materials and feedback or not. (Table 1)

## The reality link cluster

Although physicists believe that they are learning about the real world when they study physics, the context dependence of cognitive responses opens a possible gap between faculty and students. Students may believe that physics is related to the real world in principle, but they may also believe that it has little or no relevance to their personal experience. This can cause problems that are both serious and surprising to faculty. When an instructor produces a demonstration that has been “cleaned” of distracting elements such as friction and air resistance, the instructor may see it as displaying a general physical law that is present in the everyday world but that lies “hidden” beneath distracting factors. The student, on the other hand, may believe that the complex apparatus is

**Table 1.** Clusters for dimensions probed by the MPEX Survey.

	<b>Favorable</b>	<b>Unfavorable</b>	<b>MPEX Items</b>
<b>independence</b>	learns independently, takes responsibility for constructing own understanding	takes what is given by authorities (teacher, text) without evaluation	1, 8, 13, 14, 17, 27
<b>coherence</b>	believes physics needs to be considered as a connected, consistent framework	believes physics can be treated as separated facts or "pieces"	12, 15, 16, 21, 29
<b>concepts</b>	stresses understanding of the underlying ideas and concepts	focuses on memorizing and using formulas	4, 19, 26, 27, 32
<b>reality link</b>	believes ideas learned in physics are relevant and useful in a wide variety of real contexts	believes ideas learned in physics are unrelated to experiences outside the classroom	10, 18, 22, 25
<b>math link</b>	considers mathematics as a convenient way of representing physical phenomena	views the physics and the math independently with no relationship between them	2, 6, 8, 16, 20

**Table 2.** The reality link selected in MPEX

<b>Item</b>	<b>Question</b>
10	Physical laws have little relation to what I experience in the real world.
18	To understand physics, I sometimes think about my personal experiences and relate them to the topic being analyzed
22	Physics is related to the real world and it sometimes helps to think about the connection, but it is rarely essential for what I have to do in this course.
25	Learning physics helps me understand situations in my everyday life

required to produce the phenomenon, and that it does not occur naturally in the everyday world, or is irrelevant to it. A failure to make a link to experience can lead to problems not just because physics instructors want students to make strong connections between their real-life experiences and what they learn in the classroom, but because learning tends to be more effective when linked to real and personal experiences. In MPEX tool the four items have been included as the reality link cluster are items 10, 18, 22, and 25 (Table 2).

## RESULTS

In this paper we discussed the use of the multimedia related to real life in teaching physics in high school. The plan was constructed to probe student expectations with a focus on the link between physics and the real world. To investigate students' attitudes we used reality link of MPEX. In MPEX the responses of the survey for experienced university faculty is called expert responses. The responses that are preferred by students and which are most commonly found in the experts as favorable. In

this survey those responses that disagree with experts and have often found in students more concerned with grades than with learning considered as unfavorable (Redish, 2001). In reality link in MPEX the Favorable responses depending experts includes believes ideas learned in physics are relevant and useful in a wide variety of real contexts and unfavorable includes believes ideas learned in physics are unrelated to experiences outside the classroom. From pre-test and post-test, results have shown the effects of this plan on students expectation in teaching physics. The group that used interactive multimedia environment were more successful in MPEX reality link questionnaire than the other group. In addition they found new link to reality and usage of physics laws in everyday life. It is a method teacher could improve the viewpoints of students about physics in their daily experiments. We find explicit answer to the research question "What is the relation between instructional contexts with students' expectations, attitudes, and epistemological beliefs about physics and physics learning, in traditional learning and interactive multimedia related to real life"? Examining their written exams proved a magnificent improvement in

**Table 3.** The initial state and the change of student expectations in reality cluster

Group Test	Fairly Favorable responses
Control Group (I) pre test	69%
Control Group (I) post test	55%
Experimental Group (II) pre test	78%
Experimental Group (II) post test	89%

experimental group in learning physics concepts. Students who were target of this research were very active in learning concepts and their ability to analyze the real life phenomena was improved. In addition responses to MPEX reality link have shown this results: The percentage of responses in pre test ranging from 69% (control group), 78% (experimental group) fairly favorable. The results of experimental group for post test were ranging from 55% (control group), 89% (experimental group) fairly favorable. In experimental group a significant number of students saw physics as being associated primarily with interesting and exotic phenomena but some of them did not see a link between physics and their personal experiences. (Table 3)

## CONCLUSION

This has the advantage of providing more practice for students so reinforcing learning and enabling students to make links across different domains. The results of assessments and pre and post tests proved that: Students' ability to analyze the real life phenomena improved. Students were being able to make links across different domains. Students generally found the context approach through interactive multimedia more accessible, interesting and memorable than their previous experiences of physics learning.

Depending on data in this research the post test for control group had a reduction (69%: pre test to 55%: post test) which is questionable. How could it be discussed in traditional teaching? One of suggestions could be that with taking reality link of MPEX as pre test in control group ,students' expectation about their classes were improved and it shows the effects of taking a test for students as a pre test .The other researches will analyze this reduction. Finally the importance of knowing how to choose appropriate content for students to arouse their interest and give a correct view of physics to deal with real life is considerable. It is important for next researches to work on mixing different fields in dealing with real life, for instance the hands on and multimedia could be better to get more improvements in students learning and expectation.

## APPENDIX

Teaching strategy (for one session):

1. Show a demonstration to the students, ask them to explain it using a concept that was tested before, and decide how they will test their explanation.
2. Ask the students to predict the results of a demonstration before they see it using a concept that they have tested before and then reconcile their prediction with the actual experiment.
3. Perform a demonstration. Ask students to predict what will happen if some parameter in the experiment is changed using the concepts that they have constructed before.

Example: A candle is lit on a plate with a small layer of water and then covered with a glass jar. Students observe that after a short time, the candle goes out and water goes into the jar (Etkina et al., 2002).

In each part of above activities ask students to browse on the below web address:

[http://www.physics.org/interact/physics-life/web/physics\\_life/](http://www.physics.org/interact/physics-life/web/physics_life/)

To predict which part of website could introduce the other concepts related to demonstration .Therefore they will find more physics concepts related to real life in multimedia through animation and images and how they could link them together.

Ask students in their groups to find basic concepts of demonstration in multimedia and realize the daily usage of them in life. Motivate them to explain their ideas in each group and write an essay about their findings.

## Guideline for instructor

One suggestion could be: Go to the above web page .Click to enter school. Click to the Fizzy drink .The explanation about Fizzy drink will appear. Encourage students to read and have a discussion about the Fizzy drink process in their group .Ask students to discuss about relation between physics concepts of candle demonstration and Fizzy drink shown in multimedia.

**REFERENCES**

- Carney R, J Levin (2002). Pictorial illustrations still improve students' learning from text, *Educ. Psychol. Rev.* 14, 5.
- Etkina E, A Van Heuvelen, DT Brookes, D Mills (2002). Role of experiments in physics instruction – a process approach, *Physics Teacher*, 40, 351-3554
- Heron PRL, PS Shaffer, LC McDermott (2004). Research as a Guide to Improving Student Learning: An Example from Introductory Physics, Invention and Impact, Proceedings of a Course, Curriculum, and Laboratory Improvement Conference, 37
- Mayer R (1997). Multimedia learning: Are we asking the right questions?, *J. Educ. Psychol.* 32, 1.
- Mayer R (2001). *Multimedia Learning* (Cambridge University Press, New York).
- Moreno R, Roxana RM (1999). Cognitive principles of multimedia learning: The role of modality and contiguity, *J. Educ. Psychol.* 91, 358.
- Mousavi S, R Low, J Sweller (1995). Reducing cognitive load by mixing auditory and visual presentation modes, *J. Educ. Psychol.* 87, 319.
- Mudde RF (2008). *Physics of daily life*, 3.
- Redish EF (1994). Implications of cognitive studies for teaching physics, *Am. J. Phys.*, 62(9), 802
- Redish EF (2001). Student Expectations in University Physics: Using The Maryland Physics Expectations Survey, © U. of MD PERG.
- Sadaghiani HR (2012). Controlled study on the effectiveness of multimedia learning modules for teaching mechanics, *PHYSICAL Review Special Topics - Physics Education Research* 8, 010103.
- Whitelegg E, C Edwards, *Beyond the laboratory* (2002). *learning physics using real-life contexts*, *Research in Science Education- Past, Present, and Future*, Part 6, 337-342, DOI: 10.1007/0-306-47639-8-48