A PHYSICS LESSON DESIGNED ACCORDING TO 7E MODEL WITH THE HELP OF INSTRUCTIONAL TECHNOLOGY (LESSON PLAN)

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ABSTRACT

Students enter the classrooms with a preexisting knowledge of science concepts. These science concepts sometimes show inconsistency with the accepted ones by the scientists and called as misconceptions. Studies applied science field have to get possession of abilities that not only detect these misconceptions also help to solve these problems. Hence, instructional methods that correct students' misconceptions become important. In this sense, a material related to the physics course is designed according to 7E model with the help of instructional technology.

Keywords: **Physics Education, Instructional technology, 7E model.**

INTRODUCTION

Learning starts from birth and occurs in every day of human life. Children learn from their own explorations of the environment (parents, siblings, peers, movies, television, radio, CDs, books, magazines, museums etc). Consequently, children do not enter the classrooms as blank board, but they enter classrooms with a preexisting knowledge of science concepts. These concepts may be incorrect, incomplete or ineffective to explain the scientific phenomena. Students' conceptions which are inconsistent with the ideas of scientists have been called 'misconceptions' (Helm, 1980; Fisher, 1985; Huddle, White and Rogers, 2000; Marques and Thompson, 1997), "alternative conceptions" (Arnaudin and Mintzes, 1985; Lin and Cheng, 2000), "naive theories (Mintzes, 1984), or 'children science' (Gilbert, Osborne and Fresham, 1982). Misconceptions affect further learning negatively. They are persuasive, stable and resistant to change (Driver and Easley, 1978; Fredette and Lockhead, 1980; Osborne, 1983). If the misconceptions are not corrected, new learning can be encumbered or it might not take place at all.For three decades, students' understanding of natural phenomena has become focus for the science education studies (Nussbaum and Novak, 1976; Erickson, 1979; Aguirre and Erickson, 1984; Smith and Anderson, 1984; Renner, Abraham, Grzybowski and Marek, 1990; Bar and Travis, 1991; Westbrook and Marek, 1991 and 1992; Abraham, Williamson and Westbrook, 1994; Balcı, 2004). One view of learning is based upon behaviorist/objectivist theories commonly called directed instruction.

A second view of learning is based upon the notion of knowledge construction. Behaviorist theory suggests that students' behavior is the result of acquiring information and displaying that knowledge in performance. A modern metaphor of behaviorist theory is the information-processing model. In a constructivist's theory, learning is a modification of experiential memory to be more consistent with the present experience. Three principles of constructivism are:

- **knowledge is actively constructed by the learner;**
- **coming to know is the process of organizing and adapting the world to the learner's experiences; and**
- **the learner does not discover an independent world outside his mind (i.e. The discovery is constructed from ideas within his mind) (Gadinidis, 1994).**

As constructivism itself posits, knowledge is not a static phenomenon, it changes as we engage in new experiences that test what we know. These new experiences may cause us to alter or add to our understanding, sometimes in subtle ways and sometimes dramatically (Zahorik, 1997). Constructivists propose arranging instruction around problems that students find compelling and that require them to acquire and use skills and knowledge to formulate solutions. Constructivists call for more emphasis on engaging students in the process learning than on finding a single correct answer (Roblyer, Edwards, and Havriluk, 1996). A definition of constructivism is based on the fundamental assumption that people create knowledge from the interaction between their existing knowledge or beliefs and the new ideas or situations they encounter (Airasian and Walsh, 1997). Students create knowledge from the interaction of their existing knowledge and beliefs with the ideas put forth in the class discussion (Airasian and Walsh, 1997). The teacher uses facilitative techniques to foster that discussion among all members of the class.

There are three reasons for basing teaching on Piaget's constructivism: It is a scientific base explaining human knowledge, it is the only theory that explains children's construction of knowledge and it informs educators of distinctions on how different subjects should be taught (Kamii and Ewing, 1996). Lev Vygotsky's socio-cultural theory parallels the constructivist notion. He declares that social experience shapes thinking and individual cognition occurs in a social situation.

The group interaction, he stated, is part of the learning process of individuals who jointly construct meaning from peers and teacher collaboration (Jaramillo, 1996). Although most constructivist classrooms feature active, social and creative learning, different kinds of knowledge invite different constructivist responses, not one standard constructivist approach. How can a teacher create appropriate targeted constructivist responses to learners' difficulties? One approach to the challenge recognizes that different kinds of knowledge - inert, ritual, conceptually difficult, and foreign-are likely to prove troublesome for learners in different ways (Perkins, 1999). Inert knowledge is that knowledge that is hidden and not easily applied to everyday experiences. Ritual knowledge is that which is applied without forethought and concern for context.

Conceptually difficult knowledge is that which is distant from most experience and therefore difficult to place in context. Foreign knowledge is difficult to accept in time or place such as history or culture. Each type of knowledge is best acquired by different approaches to construction.

In this paper we will show that constructivist views are useful in teaching though discussion using computer. The class which uses 7E model of constructive learning approach with computer is able to engage each participant at length and in detail on the construction of common understanding and paper discusses effect of constructivist learning with computer as a learning environment. 7E model is an instructional strategy, which is compatible with science first assesses students' misconceptions and then promotes conceptual change. (Barman, 1997; Karplus and Thier, 1967; Lawson, Abraham and Renner, 1989; Lawson, 1995). 7E model promotes scientific understanding and thinking abilities among students. With the infusion of computer into the education, lessons aided computer provide the teacher with a more effective way to transfer knowledge and information to students. These lessons also enable the students to learn in a more productive way. We have combined computer and 7E model as an instructional strategy. The courseware is used as instructional software for teachers of science.

In the courseware we applied 7E model as an instructional design to computer. We have used 2D and 3D models, animations and java applets for the electrostatic topic in physics lessons. This courseware can use for the all grade level of high school and university. The courseware consist multimedia physics lessons. The multimedia part is an instructional tool for the teacher that s/he can use in the lesson. This part is designed according to 7E model and also consists of additional parts for the students who have difficulty to understand the lesson and students who easily grasp the content and needs further explanation related with the topic.Using *7E* constructivist model: *excite, explore, explain, expand, extend, exchange, and examine,* teachers are better able to articulate their educational purpose for their selection and defend the appropriateness of the chosen technology. Another advantage of incorporating the use of the 7E model is best summarized in the quote below. The theory of constructivism encourages educators to focus on making connections between facts that are required and tailoring instructional strategies that allow students to actively construct meaning and foster understanding of objectives. Effective use of technology is the perfect instrument to achieve this goal.

Excite

In this stage, students' prior conceptions will be tried to be identified. The activities in this section capture the student's attention, stimulate their thinking and help them access prior knowledge. A question containing a discrepant event, a warm-up question, a question related with a misconception is asked to students.

Explore

In the exploration part an interactive exercise is designed for students to explore the concepts that will be introduced in the lesson. In this phase students explore the ideas by making observations. A simple experiment may be included in the exploration part.

Explain

In the explanation part a suggested explanation for the concepts related with the lesson are given with the support of animations, 2D and 3D models, flash, java etc.

Expand

This section gives students the opportunity to expand and solidify their understanding of the concept and/or apply it to a real world situation In the teachers resources there are pre-test, post-test, homework questions for each lesson, suggested readings and web links for the lesson, additional learning activities and lesson plans.

Extend

The addition of the extend phase to the elaborate phase is intended to explicitly remind teachers of the importance for students to practice the transfer of learning. Teachers need to make sure that knowledge is applied in a new context and is not limited to simple elaboration.

Exchange

We usually design interactive exercises, experiments for the students to apply the concepts systemically in new situations. The software programs used in this study were downloaded from the sites including qualified software programs concerning physics topics (www.lisefizik.com, http://webphysics.davidson.edu, www.falstad.com). These downloaded software programs were examined by two physics educators and one computer and instructional technologist, in order to determine whether those programs are suitable to aim of research, or not. At the end of examination, the software programs suggested by the experts were used in the instruction process.

Examine

In the examine part, teacher assesses students' knowledge and skills. Examine part is helpful for the teacher to observe whether the students gained the concepts related with the lesson correctly or not. For the examine purposes, the printable versions of the questions are provided to teachers so that teachers can hand out these questions to students.

After the evaluation part, the teacher would have some idea about the level of understanding of students in the class.

LESSON PLAN

LESSON: ELECTROSTATİC

Grade Level:
Unit: Electrostatic
Topical Outline (Learning Cycles) and timing:

Timing: 50+50 min.

- **Excite (5 min)**
- **Explore (10 min)**
- **Explain (25 min)**
- **Expand (10 min)**
- **Extend (15 min)**
- **Exchange (25 min)**
- **Examine (10 min)**

Excite Stage

The teacher will create groups of four students. Each group will be given concept map related to oxidation-reduction reactions. In this stage, students' prior conceptions will be tried to be identified. Have you ever seen anything like this?

How can you explain this occurrence?

If an incident like showed below happens, what you feel?

Explore stage

The teacher will start lesson by questioning daily life examples:

- **If you walk across a carpet in dry weather, you can produce a spark by bringing your finger close to a metal door knob. How can you explain this?**
- **When you wear or put off a sweeter, sparks occurs. Why?**
- **If we come near television, what can you see on your hair?**
- **The problem of "static cling" has been alerted by television advertising. Why?**
- **Have you ever seen created sparks by touching a doorknob after rubbing you shoes on carpet?**
- **Have you ever felt a shock when you touched the door handle of an automobile after sliding on the plastic covered seat?**

Then, the teacher will make a demonstration. S/he will show a simulation about electrostatic occurs. Then, the teacher will ask the following questions:

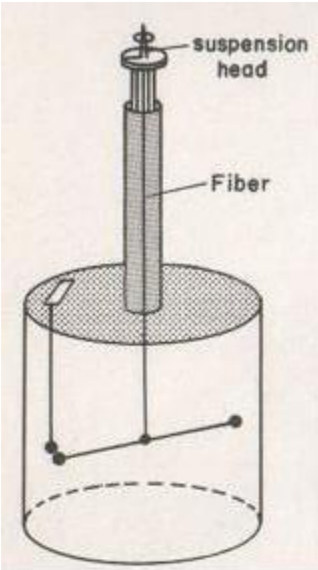


Figure 1. Coulomb's torsion balance which was used to measure the elektrostatic force betwen two charges.

1. What do you think about the following situations?
What happens if we put two same kinds of charges near themselves?

What happens if we put two different kinds of charges near themselves?

What happen if we close near a positive charged to negative charged electroscope?

The teacher will create groups of two students for each computer and s/he will allow students 5-7 minutes to think about the questions individually and then share it with their groups. Then, s/he will inform the students that they will engage in a computer activity to help them test their answers. In this stage, the purpose of the teacher is to create interest and generate curiosity in the topic of study; raise questions and elicit responses from students that will give you an idea of what they already know. Then teacher asks for discussing students each other. During the discussion, the students will have the opportunity to express their ideas and see their peers' thoughts. In this stage, the purpose of the teacher is to let the student manipulate materials to actively explore concepts, processes or skills. The teacher will be the facilitator and observe and listen to students as they interact.

Explain Stage

The teacher will listen to each group's answer. Then, she will explain the concept using students' previous experiences.You have learned in simulations that charged bodies exert forces on each other; they repel if they carry like charges and attract if they carry opposite charges.The electric force between two charged spheres was first measured in 1785 by a French physicist named Charles Coulomb. Coulomb used a torsion balance in which an insulating rod with small conducting spheres at each and was suspended by a thin wire as shown in Fig. 1. A third conducting sphere b on an insulated stand is fixed near the movable sphere a.

Both spheres, a and b, are given like charges. The force of repulsion acting on sphere a causes the horizontal rod to turn. Coulomb calibrated his torsion balance so that by measuring the deflection of sphere a from its rest position, he could calculate the force of repulsion. Coulomb proceeded in two steps.

First he gave sphere a and b like charges and measured the force they exerted on each other as the distance between them was changed. He found that *the force, F, varied inversely with the square of distance, d, between the spheres. We can write this proportionality as;*

$$F \; \alpha \; \frac{1}{d^2} \qquad \textbf{(Eq.1)}$$

The same relationship was observed when the spheres were given opposite charges and attracted, instead of repelled, each other. To investigate the relationship between the force and the amount of charge, Coulomb put a series of known different charges on the spheres and measured the force that they exert on each other when they were at a fixed distance apart. He found that *the force exerted by the spheres upon each other,* whether attraction or repulsion*, is directly proportional to the charge on each sphere and therefore to their product.* If charges Q_1 and Q_2, we can write

$$F \; \alpha \; Q_1.Q_2 \qquad \textbf{(Eq.2)}$$

Coulomb summarized his findings in a law known as *Coulomb's law.* The magnitude of the force that a sphere of charge Q_1 exerts on a second sphere of charge Q_2, separated by a distanced, is

$$F \; \alpha \; \frac{Q_{1.}Q_2}{d^2} \qquad \textbf{(Eq.3)}$$

Changing the proportionality into equality gives

$$F = k\frac{Q_{1.}Q_2}{d^2} \qquad \textbf{(Eq.4)}$$

Where k is the constant of proportionality. This equation yields the magnitude of the force that Q_1 exerts on Q_2 and also the force that Q_2 exerts on Q_1. These two forces are equal in magnitude but opposite in direction. They are examples of action-reaction forces described by Newton's third law of motion. In Eq.4, k is a constant that depends upon the units used to measure Q_1, Q_2, d and also upon the medium surrounding the charge.

Coulomb's law in the form of Eq.4 is applicable only to charged objects whose dimensions are very small compared to the distance between them. These types of charged objects are usually called *point charges.* Charged spheres can be treated as point charges.In SI, the unit of F is the Newton (N), the unit of d is the meter (m), and the unit of Q is the coulomb (c).The value of k is determined experimentally and is found to be $8{,}987.10^9$ $N.m^2/C^2$ when the measurement is performed in vacuum, or in air, to good approximation. İn our calculations we shall take it as $k=9.10^9$ $N.m^2/C^2$.

Expand Stage

The teacher asked for students investigate, describe, and explain formal concepts, and use them. Then, students ask new questions with help of prior knowledge, suggest solutions, make decision and design experiment. In this process they need incites given by teacher. So teacher must give them some information and s/he must remind them that they have adequate knowledge for this new application.

Extend Stage

In this stage, the students have just learned forces of repel-attract between matters. Simulations related to electroscope interactions (figures 2, 3, and 4) are showed to student for establish new concepts and connect these with their prior learning.

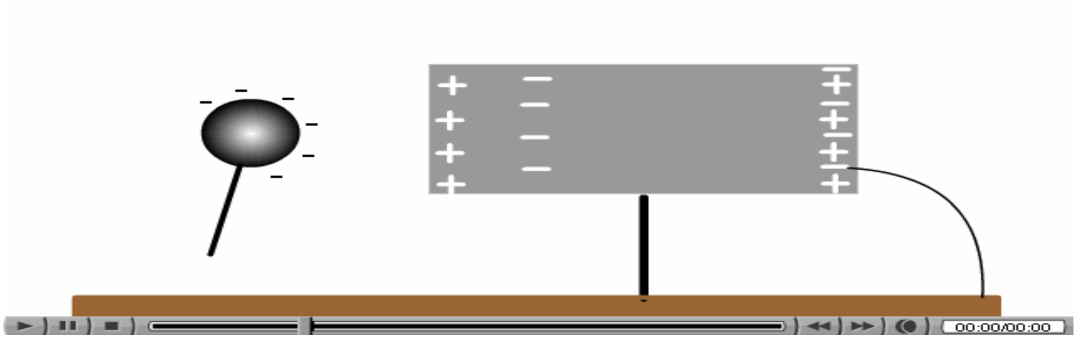


Figure: 2
Flash Animation Related to Earthing System

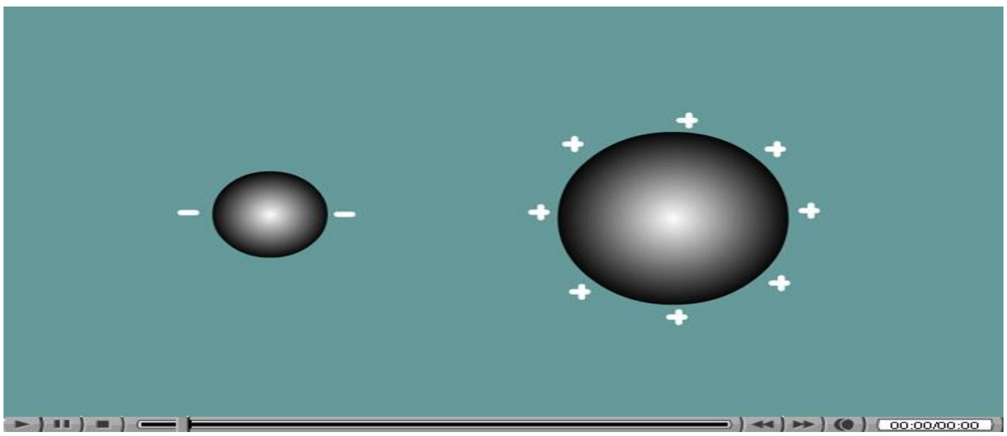


Figure: 3
Flash Animation of Two Charges Touching Each Other

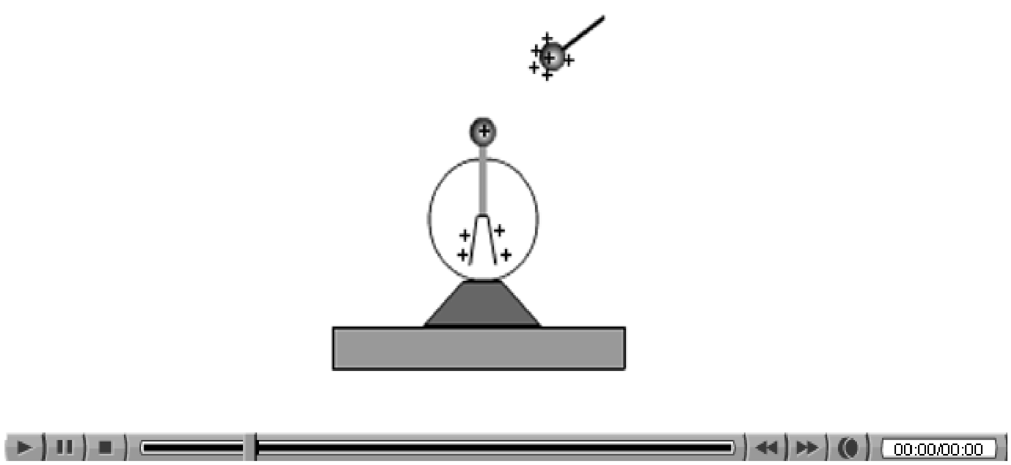


Figure: 4
Flash Animation Related to Charged Electroscope

Exchange Stage

Designed interactive exercises, experiments for the students to apply the concepts in new situations are practiced (figures 5,6,7,8,9,10,11,12,13, and 14). The students discuss new concepts and share their knowledge themselves. In this process, students' ideas may change. If they change, the students make a new plan and make new experiment through their changed ideas.

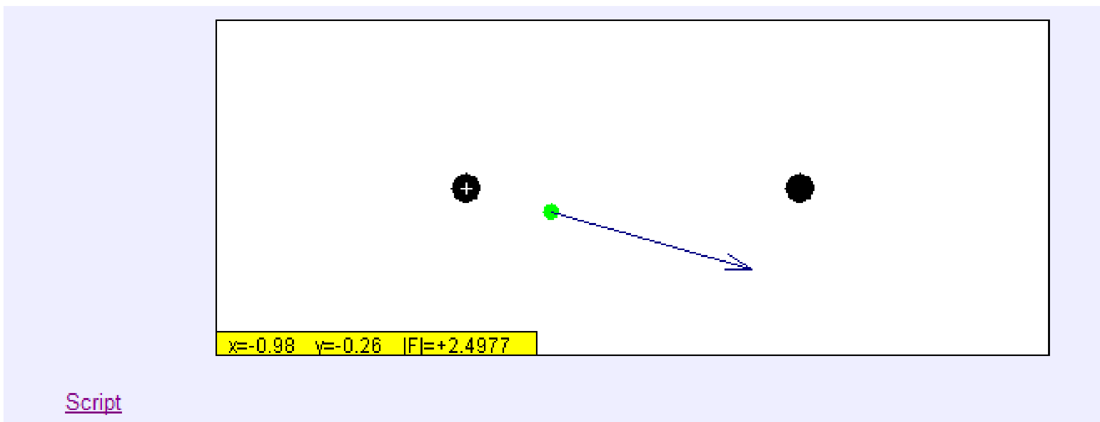


Figure: 5
Java Script Related to Coulomb Interaction-I

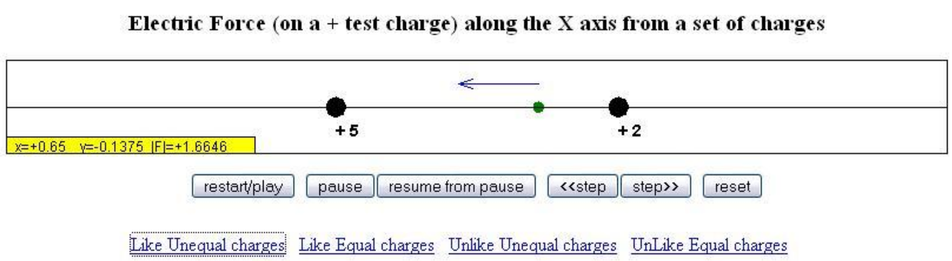


Figure: 6
Java Script Related to Coulomb Interaction-II

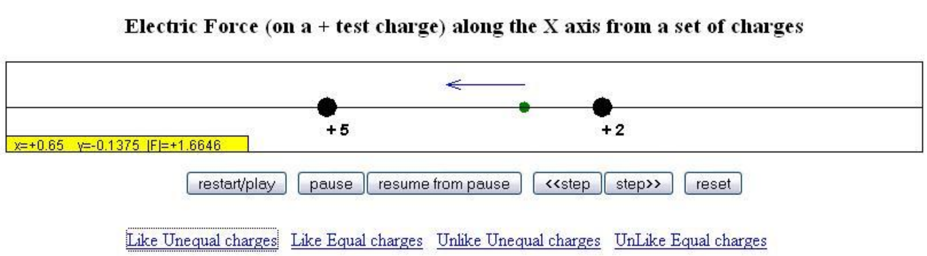


Figure: 7
Java Script Related to Coulomb Interaction-III

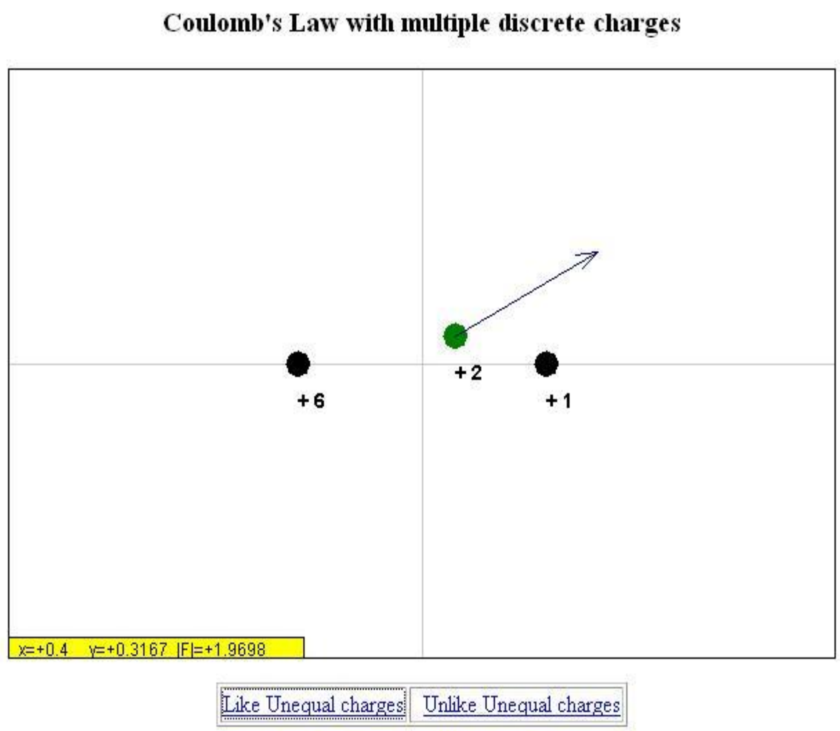


Figure: 8
. Java Script Related to Coulomb Interaction-IV

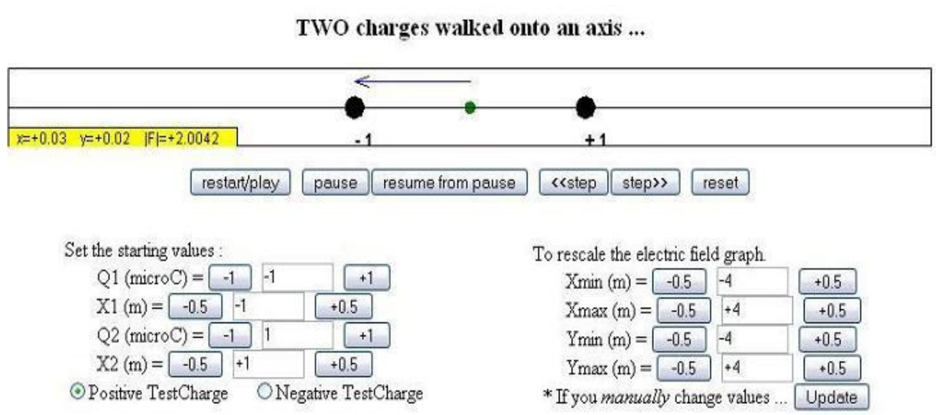


Figure: 9
Java Script Related to Coulomb Interaction-V

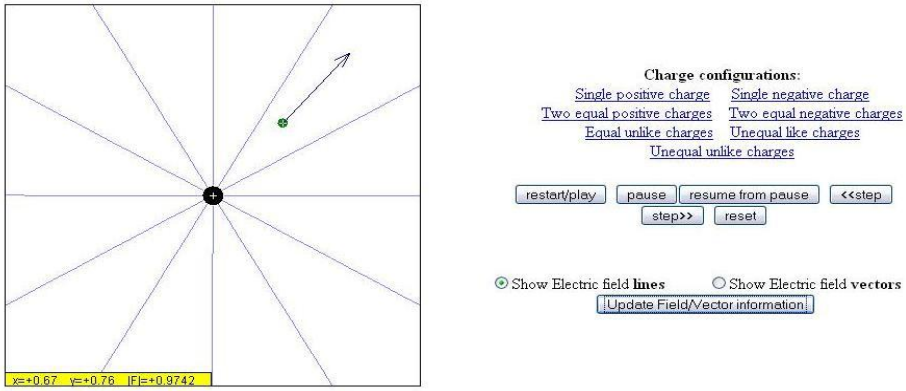


Figure: 6
Java Script Related to Electric Field

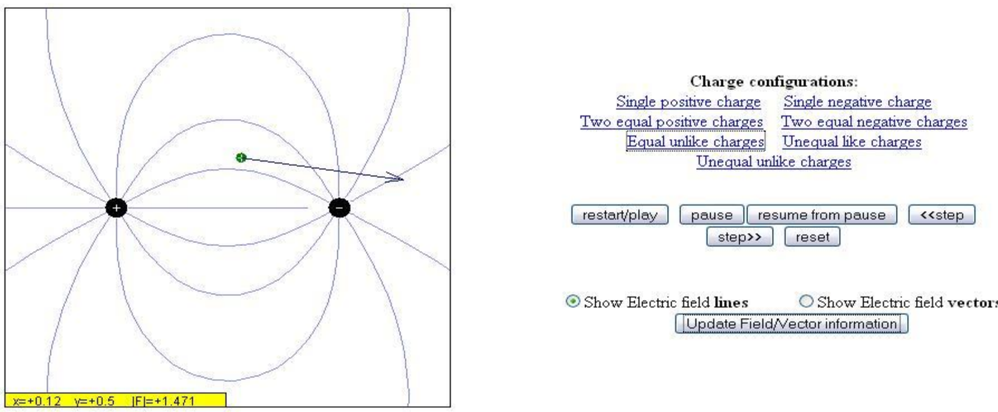


Figure: 11
.Java Script Related to Force Lines of Two Charged Particles

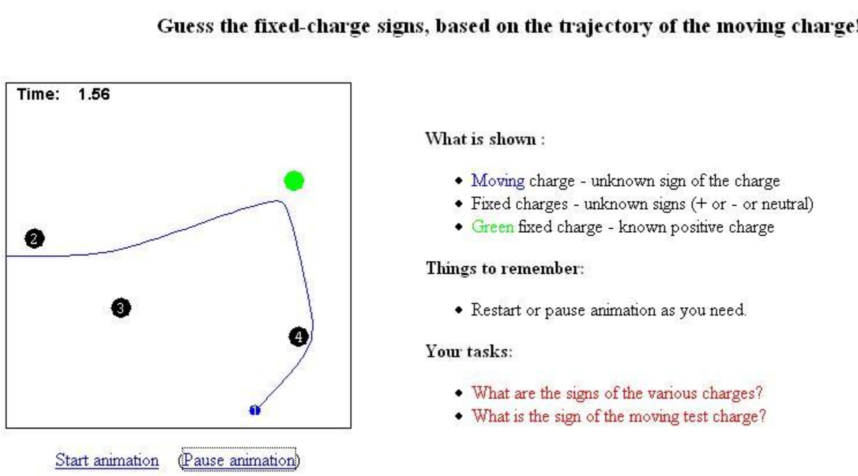


Figure: 12
An Example concerning Guess The Fixed-Charge Signs

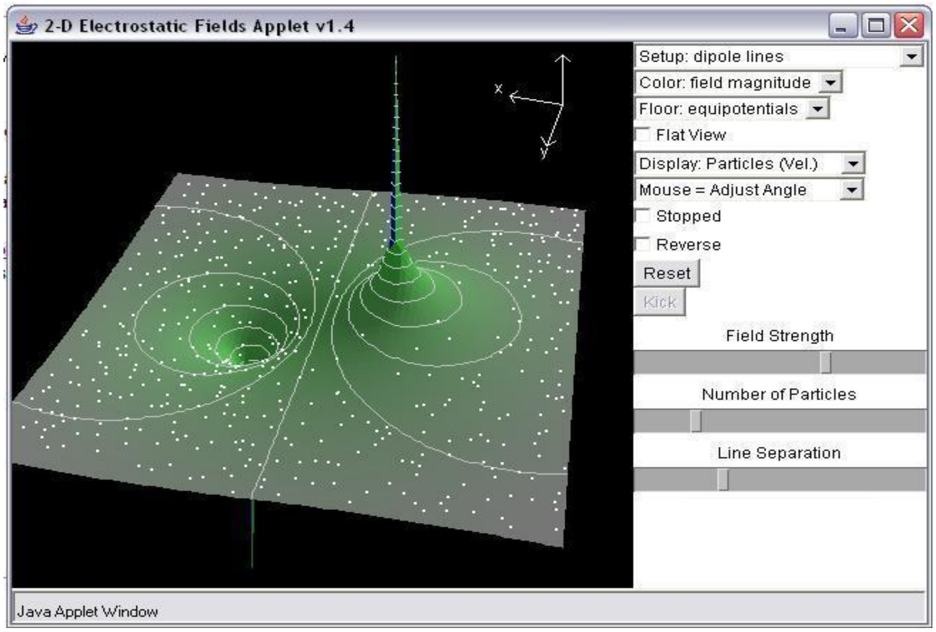


Figure: 13
. Java Applet Related to 2-D Electrostatic Fields of Two Unlike Charges

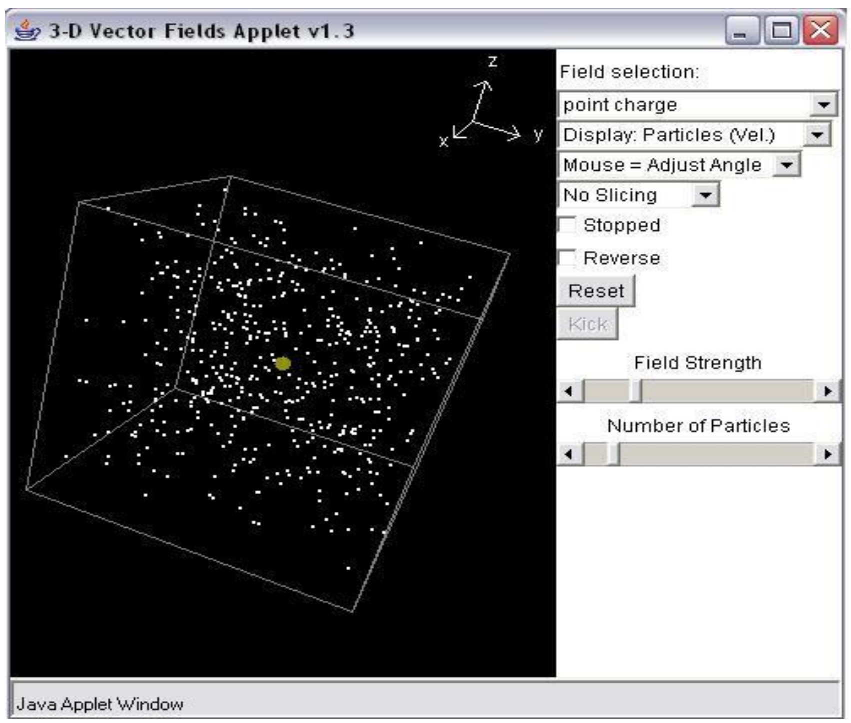


Figure: 14
Java Applet Related to 3-D Vector Fields

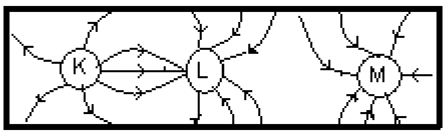
Examine Stage

The teacher will create groups of two students on each computer. Each group will be shown java applets related to topic. Then, the students will be given several questions and these questions will be discussed together.

SAMPLE QUESTIONS

1- Which particle/s in the matter brings about electrical events?
A. Electron B. Proton C. Neutron D. Electron and proton E. Proton and neutron

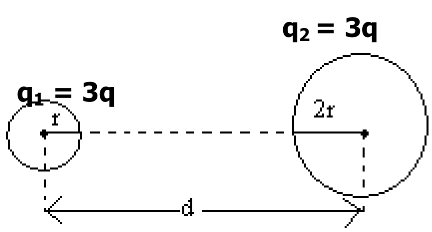
2-



Field lines of interacted three particles given above. For this figure; what is sign of K, L and M charges?

	K	L	M
A)	+	+	+
B)	-	+	+
C)	-	-	+
D)	+	-	-
E)	+	-	+

3-



These spheres repel each others with F force. If these spheres touch one another and they are sent away as far as d/2; what will be repel force between them?

A) 2F / 9 B) 8F / 9 C) 9F / 64 D) 9F / 2 E) 32F / 9

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REFERENCES

Abraham, M. R., Williamson, V. M. and Westbrook, S. L. (1994). A cross-age study of the understanding of five chemistry concepts. *Journal of Research in Science Teaching*, 31, 147-165.

Aguirre, J. and Erickson, G. (1984). Students' conceptions about the vector characteristics of three physics concepts. *Journal of Research in Science Teaching*, 21(5), 439-457.

Airasian, Peter W. and Mary E. Walsh (1997), Cautions for Classroom Constructivists, *Phi Delta Kappan*, Vol.78 No.6, pp.444-449.

Arnaudin, M. N., and Mintzes, J. J. (1985). Students' alternative conceptions of the human circulatory system: a cross- age study. *Science Education*, 69(5), 721-733.

Balcı, S. (2004). A Science Lesson Designed According to 5E Model with the Help of Instructional Technology. IV. International Educational Technologies Conference, 24-25-26 November 2004, Sakarya University, Sakarya – Turkey.

Bar, V., and Travis, A. (1991). Children's views concerning phase changes. *Journal of Research in Science Teaching*, 28, 363-382.

Barman, C. (1997). The learning cycle revisited: A modification of an effective teaching model. Monograph 6. Washington, DC: Council for Elementary Science International.

Driver, R. and Easly, J. (1978). Pupil and paradigms: A review of the literature related to concept development in adolescent science students. *Studies in Science Education*, 5, 61- 84.

Erickson, G. L. (1979). Children's conceptions of heat and temperature phenomena. *Science Education*, 63, 211-230.

Fisher, M. K. (1985). A misconception in biology: Amino acids and translation. *Journal of Research in Science Teaching*, 22(1), 53-62.

Fredette, N. H., and Lockhead, J. (1980). Students' conceptions of simple circuits. *The Physics Teacher*, March,194- 198.

Gadanidis, George (1994), Deconstructing Constructivism, *The Mathematics Teacher*, Vol.87 No.2 Feb, pp.91-97.

Gilbert, T.K., Osborne, R.T., and Fensham, P.T. (1982). Children's science and its consequences for teaching. *Science Education*, 66(4), 623-633.

Helm, M. (1980), Misconceptions in physics amongst South African students. *Physics Education*, Vol. 15, pp.92-105.

Huddle, P.A., White, M. D. and Rogers, F. (2000). Using a teaching model to correct known misconceptions in electrochemistry. *Journal of Chemical Education*. 77(1), 104-110.

Jaramillo, J., A. (1996), Vygotsky's Sociocultural Theory and Contributions to the Development of Constructivist Curricula, *Education*, Vol.117 No.1 Fall, pp.133-140.

Kamii, Constance and Janice K. Ewing (1996), Basing Teaching on Piaget's Constructivism, *Childhood Education*, Vol.72 No.5, pp.260-264.

Karplus, R., and H.D. Thier. (1967). A New Look at Elementary School Science. Chicago: Rand McNally.

Lawson, A.E. (1995). Science Teaching and the Development of Thinking. Belmont, Calif.: Wadsworth.

Lawson, A.E., Abraham, M.R., and Renner, J.W. (1989). A theory of instruction: Using the learning cycle to teach science concepts and thinking skills. *National Association for Research in Science Teaching* (Monograph 1).

Lin H. and Cheng H. (2000). The assessments of students' and teachers' understanding of gas laws. *Journal of Chemical Education*. 77(2), 235- 238.

Marques, L. and Thomson, D. (1997). Miscocneptions and conceptual changes concerning continental drift and plate tectonics among Portuguese students aged 16-17. *Research in Science and Technological Education*. 15(2), 195-222.

Mintzes, J. J. (1984). Naïve theories in biology: Children's concepts of the human body. *School Science and Mathematics,* 84(7), 548-555.

Nussbaum, J. and Novak, J. D. (1976). An assessment of children's concepts of the earth utilizing structured interviews. *Science Education*, 60(4), 535-550.

Osborne, R.J. (1983). Towards Modifying Children's Ideas about Electric Current. *Research in Science and Technological Education*, 1, 73-82.

Perkins, D. (1999), The Many Faces of Constructivism, *Educational Leadership*, Vol.57 No.3 November, pp.6-11.

Roblyer, M.D., Jack Edwards and Mary Ann Havriluk (1996), Learning Theories and Integration Models, Ch.3 in *Integrating Educational Technology into Teaching*, Prentice Hall, , pp.54-79.

Renner, J. W., Abraham, M. R., Grzybowski, E. B., and Marek, E. A. (1990). Understandings and misunderstandings of eigth graders of four physics concepts found in textbooks. *Journal of Research in Science Teaching*, 27, 35-54.

Scott, W. B., Risley, J. S. (1999). Using Physlets to Teach Electrostatics. Department of Physics, North Carolina State University, Raleigh, NC 27695 Wolfgang Christian. Department of Physics, Davidson College, Davidson, NC 28036 Published in The Physics Teacher, v 57 pp. 276-281. Retrieved April 1, 2005 from http://physics.wku.edu/~bonham/Publications/PT_article.pdf

Smith, E. L. and Anderson C. W. (1984). Plants as producers: A case study of elementary science teaching. *Journal of Research in Science Teaching*, 21(7), 685-698.

Westbrook, S. L. and Marek, E. A. (1991). A cross- age study of student understanding of the concept of diffusion. *Journal of Research in Science Teaching*, 28(8), 649- 660.

Zahorik, J.A. (1997), Encouraging - and Challenging - Students' Understandings, *Educational Leadership*, Vol.54 No.6 Mar., pp.30-32.