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Design of Training Based on Academic Skills (Training Program for Earthquake)

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Abstract: *Educational design based on the promotion of students' skills is one of the methods used for science education which helps them to achieve scientific results, such as promotion of skills that a scientist uses to understand the world, to find the order governing the world, perceive this legal system and to seek to find the relationship between his thoughts, imagination and the real world. Such skills are called science process skills. In this paper, we seek to introduce examples of methods used in teaching science process skills, especially in preliminary training for earthquake to students.*

Keywords: *Education, Science Process Skills, Earthquake Educational Content*

1. Introduction

Given that Iran is a seismic country and the exact time of the earthquake cannot be predicted, training students is essential to deal with this natural phenomenon. In Iran, planning on training earthquake to students is seeking more to find solutions to teach them how to deal with the damage of earthquake. The results of these efforts are books, pamphlets and guidelines etc., which are available to students and teachers. In recent years, the familiarity on how to deal with the earthquake for students has become so important that some decisions have been taken about the need to raise the issue of earthquake in textbooks. Given this approach, it is necessary that training on earthquake be expanded from releasing a set of guidelines at the time of an earthquake to the development of modern scientific training methods for this natural phenomenon. This requires the review of educational interests, abilities, skills and needs of students. In this paper, content and methods will be provided by science process skills for training earthquake.

Earthquake is a natural phenomenon that like other phenomena needs to be identified, investigated and regulated. In the understanding of nature human has managed to extract rules which indicate the order governing the world. By understanding the laws of nature the order governing it can be identified, and in this regard, these laws can be used to control the nature and some strategies can be designed in this way. For example, by observing the falling of objects to the ground a theory of gravity was invented, then it became law. With a better understanding of the behavior of objects around the Earth, human succeeded to invent airplanes and missiles, which move against the force of gravity. With understanding the order of nature, human could find the way to overcome the limitations of nature. Earthquake is also a natural phenomenon that the understanding of it and the order governing it can lead to find some solutions to control it and mitigate its consequences.

2. Training Program for Earthquake and Building Science

If the formation of knowledge is based on building science, it will flourish creativity in students. This method is student-centered teaching and should rely on learner's activities. Hence, the best method of training arising from it is training based on exploratory learning[1] or inquiry process. In this method, the student instead of memorizing the materials that are the product of others' thoughts, produces knowledge and passes the same path that scientists pass for the process of knowledge production, as access to the results of knowledge and their effective use is only possible through the research process. Accordingly, in the course of teaching, students are placed in situations that when they are faced with a new problem they can solve it with scientific and exploratory method and with minimal guidance from the teacher. To do this, they collect and classify information and some possible ways come into their minds to solve the problem. In this way, students achieve a set of learning and thinking skills that are easily transferable to other situations. Knowledge, skills and attitudes acquired in the process of problem solving will form a part of individual's knowledge and cognitive structure in the future that help him in the next learning experiences[2].

3. Training Program for Earthquake and Science Process Skills

Numerous studies have been conducted on science process skills and the factors that lead to the scientific knowledge. In one of these studies conducted by the American Association for the Advancement of Science (AAAS) it was announced[3] that eight skills of observation, classification, measurement, the sensing of space-time relationship, quantification, inference, dialogue and understanding, and prediction are considered as science process skills. In some cases, the skills of measurement and the sensing of space-time relationship and quantification are combined and skills are reduced to six skills. In this following these skills are introduced for training program of earthquake.

Using science process skills in scientific content design of earthquake is one of the ways that provides a particular pattern to engage students with the concept of earthquake and attempt to understand it. Activities designed in this way increase their skills for scientific knowledge of earthquake.

Observation is the first skill in the process of building knowledge. Observation is not limited to visual sense. We also see with our other five senses[4]. Considering and understanding the figures, volumes, movements, distances, sizes, colors, relative locations of objects etc. are very important and teachers should draw students' attention to details in observations. In fact, observation is the initial stage of collecting information. Therefore, all things which are observed should be carefully recorded. The teacher should introduce a variety of observation recording methods, such as writing in a notebook, drawing shapes, taking photos, filming, sound recording, etc. Strengthening the senses engaged on the understanding of objects, sounds, images, videos, models, etc., can be used for observation and students are prompted to pay attention and think with the design of appropriate activities and situations.

Hearing the sounds of earthquake is one of the interesting activities in training program for earthquake, in which the hearing is used to strengthen observation skills[1]. Hearing the sounds of different earthquakes in a region or different regions, students are asked to express their understanding of the earthquake. Then these sounds can be converted to sound waves oscillations by audio analyzer software, and strengthening observation skills based on hearing can lead to strengthening the skill of visual observation. The skill of teacher is very important in the design of questions in this stage (Figure 1). The results of these exercises are surprising, but true.

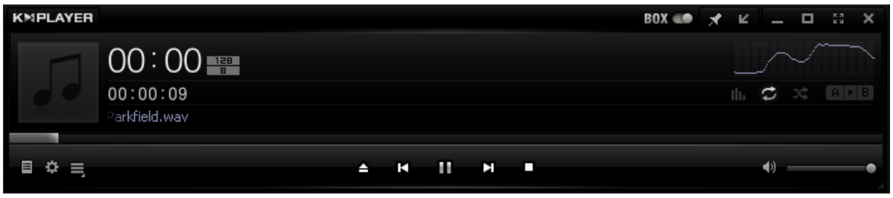

Figure1. *Sound wave oscillations recorded at the beginning of the earthquake in the Parkfield area, California (2004), 6.2 on the Richter scale*

Observation is performed for three purposes: gathering evidence and information, comparison, and classification. There is different information around us and only with careful observation the target information can be collected. The collection of information helps the learner to understand the environment better and produce the concept and learn the scientific method.

In the example of hearing the sounds of earthquake and strengthening the auditory observation skill, students can estimate the strength or weakness of two earthquakes with more practice and strengthening this skill or compare cracks in the land in two earthquakes. The test is designed by

[1]When we listen to music we hear a wide range of notes and frequencies, also when we feel the earthquake we feel a wide range of frequencies that cannot be heard as easily as musical notes. What people feel in an earthquake seems to them like a severe shaking or rolling motion. Severe shaking leads to high frequencies and rolling motion leads to low frequencies. What you feel in an earthquake is a product of vibrations and it depends on the distance between you and it and a variety of stones between you and the earthquake. To evaluate the earthquake, its vibrations are converted to sound and then the sounds are listened to.

using the sounds for the qualitative detection of earthquake intensity and is carried out in the form of playing and in this way will result in more advanced steps in the strengthening of observation skills. For example, Figures 1, 2 and 3 are related to an earthquake (with a magnitude of 6.2 in Parkfield, California, 2004); in these figures the sounds of earthquakes can be observed which are converted by audio analyzer software in the form of oscillating sound waves. Hearing earthquake sounds and observing sound wave oscillations simultaneously lead to strengthening students' observation skills. The sounds observed in the figures were recorded at the beginning, first and third seconds of the earthquake. Finding similarities and differences between these figures is one of the objectives of strengthening auditory and visual observations.

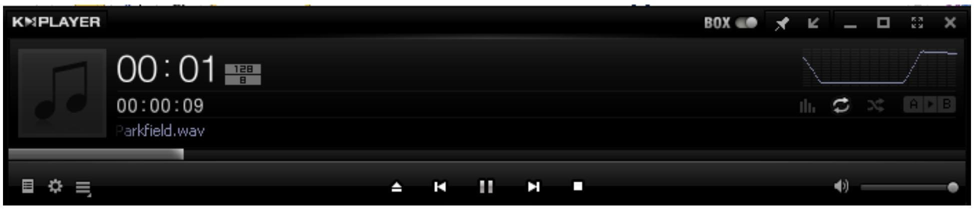

Figure2. *Sound wave oscillations recorded at the first second of the earthquake in the Parkfield area, California (2004), 6.2 on the Richter scale*

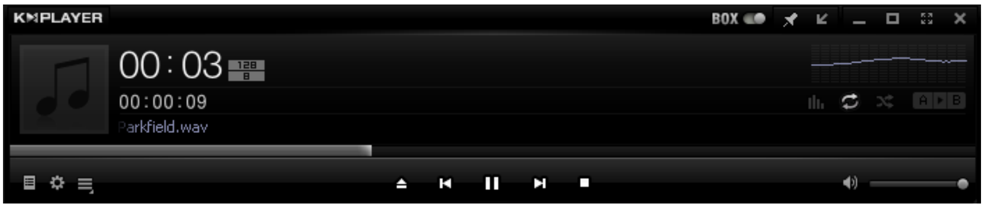

Figure3. *Sound wave oscillations recorded at the third second of the earthquake in the Parkfield area, California (2004), 6.2 on the Richter scale*

Comparing these figures encourages students to analyze the figure and find a relationship between fluctuations and sounds after the earthquake. For this, an appropriate training design in the classroom is necessary, so that students can be helped with step by step questions on their observations and acquiring information from those observations. For example, Figures 4, 5 and 6 are related to another earthquake (4.5 on the Richter scale, 2014, Geysers, California); in these figures earthquake sounds converted by audio analyzer software into oscillating sound waves can be observed. The sounds in these figures were recorded at the first, second, and third seconds of the earthquake. Finding similarities and differences between the figures can lead to strengthening auditory and visual observations. This activity is similar to the previous one and what is important is comparing these figures with the figures of Parkfield earthquake. Observation skills of students can be strengthened by very precise and purposeful design of activities in comparing previous figures and figures 4 to 6, so that using sound waves they can comment on the relationship between the intensity of earthquakes (first earthquake with magnitude 6.2 and the second earthquake with magnitude 4.5).

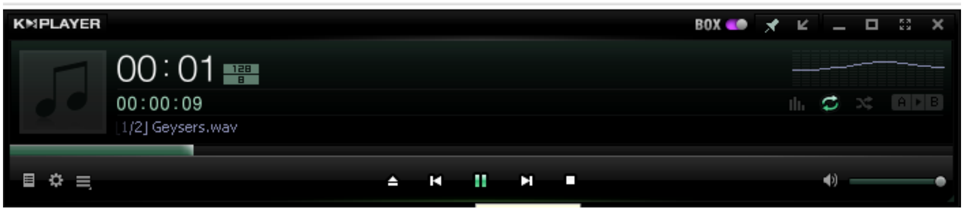

Figure4. *Sound wave oscillations recorded at the first second of earthquake in Geysers, California (2014), 4.5 on the Richter scale*

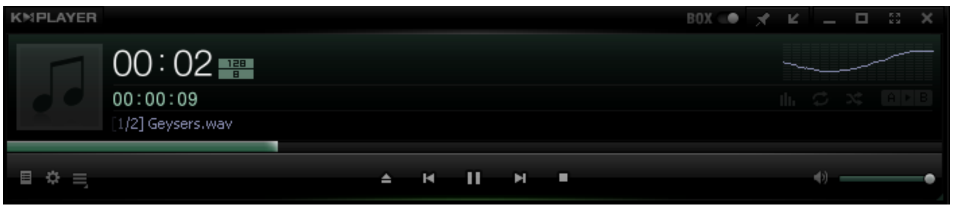

Figure5. *Sound wave oscillations recorded at the 2 second of earthquake in Geysers, California (2014), 4.5 on the Richter scale*

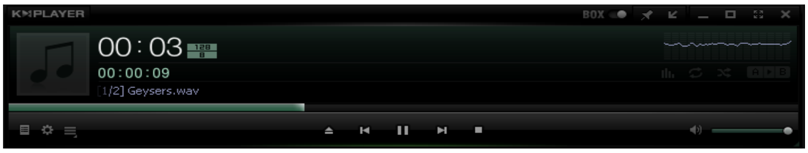

Figure6. *Sound wave oscillations recorded at the third second of earthquake in Geysers, California (2014), 4.5 on the Richter scale*

As mentioned, observation skills lead to comparison skills. These skills are introduction to classification skills. Using observation, different senses and measurement, students can evaluate common or different properties of objects and phenomena and can recognize them from each other. Students can classify phenomena and events by observing an image of a wall, building, monument, school, classroom, people, and sounds before and after the earthquake and comparing them. In Figures 1 to 6 the skills of observation, comparison, and classification can be strengthened simultaneously. In qualitative and quantitative comparison of these figures students can understand the meaning and purpose of converting vibration to sound and sound to visual waves. The use of different senses and experimental activities, such as pictures, real objects and models, observation and touch, and precise hierarchical questions can develop these skills.

Classification is a skill based on which students place a group of objects in a separate category according to the properties which are more observable. For example, students can be encouraged to categorize the words by writing words derived from brainstorming about the earthquake. To develop classification skills, visual cards of sound waves related to different earthquakes, the damage after the earthquake, necessary personal items and clothing to cope with the earthquake crisis, such as the damage of buildings etc. can be provided to students to classify them and explain their reasons and can explore disciplines and patterns in this phenomenon. In another activity children can be asked to pay attention to the arrangement of objects in their living environment and classify objects, guess different criteria of classification and explain why this arrangement is appropriate for this particular case. Even in some cases other students can be asked to guess what criterion their friends have used according to the type of classification. Another activity is to ask students to find similarities and differences between objects before and after the earthquake (such as similarities and differences between various types of a chandelier hanging from the ceiling and the clothing hung on a coat hanger). Imaginary classification is another mental activity. To strengthen the power of imagination and focus of students, they can be asked to classify the picture of several animals based on their fear and reaction caused by the earthquake.

Earthquake is a phenomenon that can be attributed to physical quantities, time-space relationship which includes the study and application of figures, distance, motion and speed is related to measurement skills. More precisely, measurement skill is making relationship between numbers and sizes, in which information is calculated in mathematicians' terms in a concise and meaningful way and is placed in the form of figures, curves, equations etc. Earthquakes like other physical phenomena can be measured. Hence, it is necessary to strengthen measurement skills in students, so that they can understand the reason of expressing the magnitude of an earthquake according to a certain unit; also they can understand the necessity of using tools which evaluate earthquake more accurately. Measurement is performed by tools and the result is a number that we attribute to our observation based on standard units. One of the activities for this skill is to familiarize students with the relationship between time and space in the earthquake. The aim of the following activity is to understand the earthquake intensity over time and to analyze the vibration figure according to time in an earthquake. Understanding that the earthquake vibration intensity is more at the beginning of an earthquake and is decreased over time is shown in this activity. We know that aftershocks occur after some earthquakes, i.e. milder earthquake occurs later at the same location; this is shown in Figure 7 about the aftershock with 2.7 Richter magnitude scale in California (1992) that occurred after one minute. Quantitative and qualitative analysis of this figure show the quantitative and relative comparison compared to the main earthquake and aftershock.

Figure7. *Simple image of the earthquake and aftershock recorded by seismograph for the earthquake of Southern California (1992) with a magnitude of 7.3 Richter*

Every child can estimate the epicenter and the time and distance from the epicenter and its effect on damage incurred and even an unspecified value of the Richter scale. Given the limitation of students' understanding of natural and real numbers and logarithmic calculations, it's better to use the comparison of damage in two earthquakes with different intensity for developing this skill and compare them with screening the two cases or showing two images after the earthquake for indicating the effects of the earthquake.

The skill building tools is another skill. Practical tasks are one of the key ways to foster creativity. A fundamental issue in using tools is building them by students. Conversion of land vibrations to sound is one of the practical activities that can be used as a way to familiarize students with the sounds of earthquake. Building a simple seismograph is another practical activity.

Inference skill is another skill, by which student's learning process is facilitated. Using this skill students should conclude about what they do not know based on what they know. Inference usually is performed by "hypothesis" making. For example, a container of nuts is dropped. By observing the nuts on the ground and the ratio of the number of dropped nuts to total nuts in the container, the directions of nuts on the ground, we make a hypothesis that the container is dropped from a height, container has a resistant material or the container has dropped from a short height. To facilitate this process, we can use images of phenomena related to falling objects or picture books or toys that are capable of building. Various activities in the classroom can be used to strengthen the skills of hypothesis making and inference. For example, for a column built by toys it can be hypothesized that if the below piece is pulled the column falls; then students can be asked raise all sorts of predictions that can be deduced from this hypothesis and tall what can be done to test and verify these predictions and what tools can be built. For example, students can be encouraged to express the reason for classification and the hypothesis for similar sounds by hearing the sounds of different earthquake and comparing them after classifying; then discuss about the components of the device which record the sound of earthquake and make them audible. The form "if ... then ..." is used in statements suggesting hypothesis. For example, "if" in the comparison of two sounds of earthquake with equal intensity, one is more bass, "then" the ground shaking is less during that earthquake. Encouragement of students to make statements in this form is actually getting a result of a hypothesis. Design of experiments and practical activities are one of the most important and most difficult stages of inquiry process. An experiment which is well designed reaches to results with the lowest number of interpretation and likely leads to a result and probability. It is necessary that a correct research path is designed to confirm a correct inference and hypothesis.

For example, comparing Figures 1 to 6 a research activity can be designed, in which questions can be asked about the images of sound wave oscillations related to larger earthquakes, such as Bam earthquake near Kerman with the magnitude of 6.6 Richter (2003) or an earthquake in the region or Khash, East of Iran with the magnitude of 8.7 Richter (2013). Answers to these questions are dependent on understanding Figures 1 to 6 and the transition from qualitative to quantitative concepts. If students can work with computer, they can be encouraged to provide a research work in this case by using audio recording software. One of the results of this activity is the development of their inference and process of a hypothesis in the form of if ... then.... For example, if an earthquake has greater intensity, then the height of sound waves is more in computer analytical figures. However, these results may be far-fetched or wrong, but the goal is to teach science skills and such training is more effective with dialogue. In some cases, teachers can guide students to the correct conclusions with the design of appropriate activities and purposeful questions, but remember that most scientists have a knowledge-seeking spirit and do not accept scientific results of others without questioning.

Today, despite remarkable progress in the field of measuring the intensity of earthquakes in various places of the world, one of the human concerns is to predict earthquake. This is the same process that after observing the facts and making hypotheses, we "predict" what will happen in the future based on these hypotheses. Earthquake prediction is very important and as it is not still possible to predict the exact time and location of earthquake, in some cases the prediction of earthquake is replaced by the forecast of earthquake. Forecast is different from prediction. A scientist who predicts something in the science will learn of his incorrect prediction, as it shows there has been an error. But an individual who predicts the future of people accidentally or by resorting to strange forces never will be happy from his false prophecy and does not consider it a sign to correct his ideas.

In this field, practical activities are designed to promote the prediction skill; for example, one of the students can be asked to pull suddenly the mat under the feet of his friend and predict what will happen when the mat is wrinkled and crumpled and when it is fully extended and smooth. In all activities designed about the prediction of earthquake, students can be asked to tell their ideas and then try it to see if their predictions will come true or not. In another task, two earthquakes at different times with different intensities in a region can be compared by showing the pictures of damage or the film of their vibrations and expressing the exact number of their magnitudes; then the prediction of the effects of an earthquake can be discussed with an intermediate intensity in this area. Another suggestion is that students predict the high-risk areas using the maps of seismic regions and population density in the country. For example, Figure 8 is the map of the damage severity in the earthquake at the distance of 123 kilometers from Bam that took place in 2014. Students can estimate the damage in this earthquake using shade guides in the map.

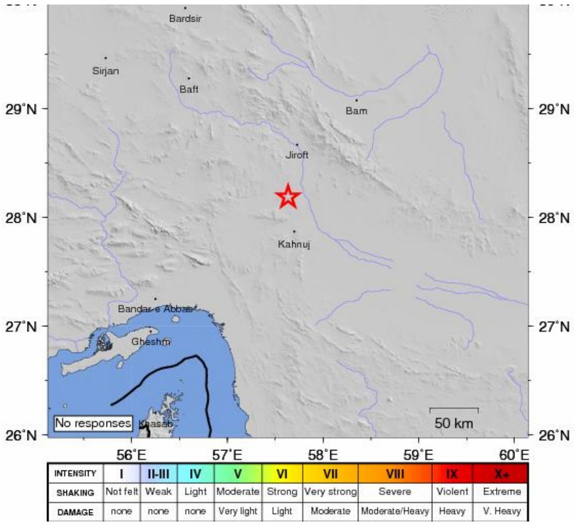

Figure8. *Map of damage severity, the earthquake of 2014, at the distance of 123 kilometers from Bam, Iran, magnitude of 4.5 Richter*

Usually in prediction, people try to tell their views based on hypotheses and convince others by talking; hence, one of the skills that should be considered in training program for earthquake is communication, conversation or exchanging ideas. Students should learn to share their thoughts with others express their views in an understandable way and easily. In this way, a relationship is established between different ideas and as a result they identify the world around better and earlier. Communication skills can be improved by providing opportunities for discussion, familiarizing students with the rules of speaking and writing, the way of developing tables and figures and using previous knowledge and skills. In the training program for earthquake, paying attention to strengthening the skill of expressing the views, providing opportunity for others' comments, mutual criticism and creating appropriate conditions to reach a common understanding are necessary.

In this paper, simple examples were provided for using science process skills approach in training program for earthquake to make the use of this approach more tangible with a practical method. Training program for earthquake is only a minor issue and an example for using science process skills approach. Science teachers can use this approach with their creative innovations for teaching diverse branches of science t and thereby facilitate learning.

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[3]Resource (1)
[4]Vitti, Debbye; Torres, Angie,(2006), Practicing Science Process Skills at Home, A Handbook for Parents,1-16