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Material development and meeting learner's need

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In this study, the aim was to show that learners' needs can be met using simple and cheap materials that can be found everywhere in 9th to 11th grade Chemistry courses. To this end, materials were developed using simple everyday life materials for 9th to 11th grade Chemistry courses. In the research, the project method was employed. The study was carried out in the 2011 to 2012 Academic Year by 9 fourth-grade students enrolled in the Chemistry Department at Ahi Evran University, as part of the course "Instructional Technologies and Material Design". The research data were collected by each student, in the format "This is My Work", by taking into consideration the eight stages. Materials designed in this project format were evaluated according to the material design principles specified by Yanpar (2007). In the end, 9 materials were developed, which could be linked with the learner's need, which was aimed at accomplishing the listed objectives, and which fitted to the "This is My Work" project format. Authors of the mentioned books might be suggested to take into consideration these materials while revising their books. Photos of these materials are presented in Appendix 1-9. By taking these materials as examples, students may develop projects all around the world by using only simple and cheap everyday life materials. This way, the learner becomes aware of the act of learning and satisfies the need to learn.

Key words: Material development, ordinary materials from daily life, high school 9 to 11 grades chemistry course book, teacher candidates in department of chemistry, needs of learners, educatioal physchology, chemistry education.

INTRODUCTION

Today, it is possible to have an adequate and qualified human resources that initiate transformations in the world in order to explain and make sense of the world as well as satisfying human needs, only by attaining an education system that catches up with, and even exceeds, the contemporary times (Aydın, 2011: 66).

In the contemporary state of affairs, technology-use is an obligation, rather than a privilege. Characteristics of individuals that societies need have undergone significant changes. Teachers, in particular, are expected to integrate technology into their classes in order to be able to train individuals of the information society. In other words, it is desired to endow students with skills to combine technology, which is a requirement of Contemporary education, and teaching-learning processes (Gündüz and Odabaşı, 2004: 47). Such skills could be provided through student-centred approaches.

In order to be able to accomplish the transition from a teacher-oriented approach to a student-oriented one, students need to be provided with more environments where they can reflect their potentials. Especially project works need to be supported and students should be enabled to present their projects (Bak and Ayas, 2008).

Environments where students can best reflect their potentials are environments where they carry out learning activities by doing-thinking. "Learning by doing-thinking" activities amount to an important strategy for science courses. Students at all ages participate more willingly

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in classes when they study using materials. Students recall the notions that emerge better than what they have been told. On the other hand, only "doing" activities without "thinking" involved does not guarantee learning; in fact, it is a waste of time and money. Students need to think about what certain data mean, how theoretical concepts can be explained and what experiment results demonstrate" (Milli Eğitim Bakanlığı [MEB], 2004: 12).

It is of importance to minimize the waste of "money" while carrying out activities. For this reason, most simple materials should be used in such activities. That is, experiments, materials and projects should be made using simple materials that are cheap and from the daily life.

Experiments conducted with simple materials do not only enable students to utilize the materials successfully but also teach them how to make sense of and draw conclusions out of the experiences obtained through experiments (Haury and Rillero, 1994 quoted in Uysal and Eryılmaz, 2002).

Since such experiments are conducted with easily-found, cheap and daily-life materials; they can be carried out even in village schools without needing to advanced facilities, and thus every student could be equally provided with the opportunity to experiment (Uysal and Eryılmaz, 2002).

Students can reflect their potentials best in laboratory environments and project works.

In the laboratory method, students learn through experiments either individually or in small groups. In this method, the student is more active than the teacher. Students acquire the skills of and experience in researching and analyzing in this method (Geban, 1996: 68).

Like in the laboratory method, students are also more active than their teachers in the project method (Geban, 1996: 68; Aykaç et al., 2006: 211). The project method, which is used most in science courses, is based on students' active participation. The project should be appropriate to students' knowledge levels and it should attract students' attention. Besides, the teacher in this method should guide students at certain stages (Aykaç et al., 2006: 211).

Students' interest can be enhanced by assigning them projects that will meet their demands and needs.

Projects are of importance in terms of satisfying the needs of "the subject, the learner, and the society", as Taba (1962) and Tyler (1949) suggests.

In our time, in which knowledge is rapidly increasing and technological advancements are very fast, individuals who are capable of effectively solve scientific and technological problems are needed in all lines of work. This fact points to the necessity of improving science literacy among all students. To accomplish this; teachers should;

- be aware that students learn at different paces and in different styles,
- use material methods that fit to students' levels of development and styles of learning and that provide various individual and cooperative learning environments,
- use materials that do not discriminate between genders, and that take into consideration students' varying linguistic skills, special talents, physical handicaps and learning difficulties,
- ensure that their teaching/learning strategies are suitable for the needs and skills of all of their students (MEB, 2004: 23).

Learners' needs may be satisfied by translating the subject into the language that students would understand without allowing misconceptions (Shulman, 1986, 1987 quoted in Graf et al., 2011). This need is expressed by Demirel (2011: 74) as the individual's living in the society in harmony, and his/her desire to have a good job to be able to obtain financial gains. In addition, misconceptions negatively influence not only the individual's educational life, but also his/her professional life (Turgut and Gürbüz, 2012).

Problem situation

The individual is at the centre in the constructivist learning approach, which is regarded as a "phenomenon" (Avenstrup, 2004) in our global village (Piaget, 1926 quoted in Gustave, 2003: 36). This individual is someone - i) who solves or seeks answers to scientific and technological problems, ii) earns out of his/her scientific and technological knowledge, iii) communicates using languages used in science and technology (PFéQ). In the global village, satisfying the "learning need" of the individual is paramount. This need can be satisfied by enabling the individual to use questioning-researching activities, used while doing science (MEB, 2004: 11), with materials that allow him/her to learn using more sensory organs (Yanpar, 2007: 10). While preparing such materials, it is important to use simple and cheap ingredients that can be found anywhere and solid waste plastic items that pollute the environment. Thus, both the individual's learning need will be satisfied and s/he will become a voluntary environmentalist. Waste materials, which are produced to meet the demand of such environmentalists, will be reused in the classroom environment as teaching materials. Since the relevant literature is limited, it is believed that this study will make a good contribution to the literature. For all these reasons, the current study is of significance.

Conceptual framework

Kant suggested that "the space of things is the human mind" (Yalçın, 2012). In this space, designing is performed. In other words, design is the way "things" are imagined (Kaya et al., 2010: 20). On the other hand, it was suggested by Socrates and Einstein that "things are placed through thinking" in the above-mentioned space (Yıldırım, 2009; Güran, 2011). Hegel argued that "things" are seen by way of thinking (Yalçın, 2012). "Things" placed in mind through analogies, which are wings of thinking (Aydın, 2012: 159) point to "the purpose of science, if they are oriented towards the understanding and explanation of the natural world" (MEB, 2004: 6), and to "the purpose of technology, if they take the form of making alterations in the natural world with the aim of satisfying human needs and demands" (MEB, 2004: 6). Artificial materials are used along with natural ones for the purpose of satisfying human needs and demands. Plastic items, in particular, have become one of the most important commercial goods today; as they are light, cheap, easily-processed and used in numerous areas. We use large amounts of plastic in our daily lives. Environmental pollution is exacerbated as these materials are thrown away after a single use and as they are voluminous (Yurtseven et al., 1997: 23). Among these everyday materials are; plastic bags, toys, plastic bottles, cables, artificial organs, medical supplies, fibre, surfacing materials, pipes, films, cassette boxes, glasses, plates, lamps, isolation materials, foamed materials, rubber materials, composite materials, and so forth (Yurtseven et al., 1997: 24).

It is of importance to use these materials as learning materials in the activities performed in the teaching-learning environment (Yanpar, 2007: 5); because learning materials enable students to learn through as many sensory organs as possible (Yanpar, 2007: 10). This way, the learner satisfies his/her "learning need" (Ülgen, 1994: 183). Moreover, while this need is satisfied, solid waste plastic materials are recycled. Thus, the idea expressed by Karl Popper that "all life is problem solving" (HPÇ) is realized.

Research objective

In this study, it was aimed to satisfy learners' learning needs using simple and cheap daily life materials that could be found anywhere in 9th to 11th grade Chemistry courses. In this framework, it was aimed to develop teaching materials inorder to achieve the following objectives:

Periodic Table Calendar

- Demonstration of the Relationship between Electron Affinities and Atomic Diameters of 7A Elements of F, CI, Br and I,
- 3-D Demonstration of the Concept of Polymer,
- Demonstration of the Intervals where pH is Acidic, Basic and Neutral through a Portable Pepper-Soap-Salt Model,
- 3-D Demonstration of Chemical Bonds,
- Lightened 3-D Portable Model of Saturated and Unsaturated Hydrocarbons,
- Lightened Portable Model that Represents Tendencies of Some Elements to Accept or Donate Electrons,
- 3-D Demonstration of Atomic Electrons, Protons and Neutrons,
- 3-D Portable Model of Matter's Granular Structure

Research questions

In satisfying the sample "learning need" as part of the research;

- Which easily-found, simple and cheap items are used in the preparation of which teaching material?
- Which solid-waste plastic items that pollute the environment are used in the preparation of which teaching material?

METHOD

In this study, the project method was employed. This method is a sort of individual learning method, in which every student takes part in research on the subject or on an aspect of the subject. In this research, the student firstly identifies the problem, then determines changes, and finally offers solutions (Aykaç et al., 2006: 211). Projects not only help students conduct scientific researches but also enable them to accumulate in-depth knowledge on a subject (Gürdal and Öztuna, 2010).

According to this method, in problem solving generally at the elementary education level, the "This is My Work" project format (MEB, 2012: 24) and the material preparation principles proposed by Yanpar (2007: 155-159) are taken into consideration.

The main headings of the "This is My Work" project format are presented as follows (MEB, 2012: 24):

1. Project name,
2. Project's objective,
3. How did the idea of project come up,
4. General information about the project,
5. Materials used in the project,
6. Techniques and methods used during the execution of the project,
7. Stages of the execution of the project,
8. Conclusion and suggestions.

Material preparation principles, on the other hand, are presented as follows (Yanpar, 2007: 155-159);

1. Teaching material should be simple and understandable.
2. Teaching material should be in line with the objectives and acquisitions of the course, and it should be prepared in a way that supports the curricula.
3. Teaching material should be equipped only with important and summarized information regarding the subject, rather than all the information about the subject.
4. Visuals to be used in the teaching material (pictures, graphs, colours etc.) should not be overused; they should emphasize the important aspects of the material.
5. Text and visual/auditory elements to be used in the teaching material should be in harmony with students' pedagogical characteristics, and they should be consistent with students' daily lives.
6. Teaching material should allow students to practice and

experience.
7. Teaching materials should reflect the daily life as much as possible.
8. Teaching materials should be accessible and usable by all students.
9. Materials should so simple that not only teachers but also teachers could easily use.
10. Materials that will be used again later should be durable.
11. Teaching materials should be easily improvable and updatable.
12. Assistance should be taken from the immediate environment while preparing a material.
13. Preparation and operation manuals should be formed for materials.

In this study, subject of Chemistry course books for 9^{th} to 11^{th} grades (MEB, 2008, 2010, 2011) were examined, and then it was determined whether the existing teaching materials for these subjects were sufficient or not. Then, in the preparation of teaching materials for these subjects, the material preparation principles proposed by Yanpar (2007: 155-159) and the eight principles as part of the "This is My Work" project format (MEB, 2012: 24) were used, and the objectives desired to be accomplished at the end of the projects were listed. Besides, the literature was reviewed in order to figure out whether other materials in the "This is My Work" project format had already been prepared or not. Similar subjects were excluded from the scope of the study. Special emphasis was put on having original subjects.

Study group

The study was carried out in the 2011 to 2012 Academic Year by 9 fourth-grade students enrolled in the Chemistry Department at Ahi Evran University, as part of the course "Instructional Technologies and Material Design". Of these students; 78% were female and 22% were male. The research was carried out individually with these students. However, as part of the action plan prepared for the research (MEB, 2012: 24; Yanpar, 2007: 155-159), area and education experts, students and parents were also included in the research. One-to-one opinions were asked from these parties during the research. For example, they were asked whether the prepared materials satisfy the needs of "the subject, the learner, and the society", which is specified by Taba (1962) and Tyler (1949). Area experts were asked whether the needs of the subject are met, education experts were asked whether these needs are satisfied with misconceptions, students were asked whether the needs of the learner are met, and parents were asked whether the needs of the society are met.

Data collection instrument

Data were collected by each student by considering the following eight stages of the "This is My Work" project format (MEB, 2012: 24);

- Name of the project,
- Purpose of the project,
- How did the initial idea come up,
- General information about the project,
- Materials used in the project,
- Method used during the execution of the project,
- Execution stages of the project,
- Conclusion and suggestions.

Analysis of data

Materials designed in this project format were evaluated according to the material design principles specified by Yanpar (2007: 155-159).

Of the principles, the sixth was considered in the selection of subjects from the course books (MEB, 2008, 2010, 2011), and the ninth was used in determining the simplicity of materials to be developed for the use of students in a game format.

FINDINGS

In this research, data were collected and evaluated with reference to the "This is My Work" project format. Therefore, the data were collected and presented under eight categories.

Project name

A total of nine original material subjects were identified (six from the 9^{th} grade, two from the 10^{th} grade, and one from the 11^{th} grade Chemistry books). The subjects included in the scope of the study are presented in Table 1.

Purpose of the project

It was determined that the subjects specified in Table 1 are not presented in the material format in those text-books. It was aimed to present them in the material form.

How did the initial idea come up?

The activities used in the presentation of the subjects specified in Table 1 contradict with the Principle 6 of Yanpar's (2007) material development principles. According to this principle, "teaching material should enable the student to practice".

General information about the project

A literature review was conducted on the subjects presented in Table 1. Moreover, the literature was also reviewed in order to find out whether materials in the "This is My Work" project format had already been developed on these subjects. Similar subjects were excluded from the scope of the study. Special emphasis was put on having original subjects.

Materials used in the project

Materials used in the development of the Teaching Materials 1 to 9, as presented in Table 1.
In the preparation of the Material 1;

- Cardboard, 1 reading lamp, 3 coloured cardboards

Table 1. Nine original material subjects of the study.

No.	Subject	Appendix
1	Periodic Table Calendar (MEB, 2010: 80-88)	1
2	Demonstration of the Relationship between Electron Affinities and Atomic Diameters of 7A Elements of F, CI, Br and I (MEB, 2010: 109-110)	2
3	3-D Demonstration of the Concept of Polymer (MEB, 2008: 124-128)	3
4	Demonstration of the Intervals where pH is Acidic, Basic and Neutral through a Portable Pepper-Soap-Salt Model (MEB, 2011: 158)	4
5	3-D Demonstration of Chemical Bonds (MEB, 2008: 36-37)	5
6	Lightened 3-D Portable Model of Saturated and Unsaturated Hydrocarbons (MEB, 2008: 84-85)	6
7	Lightened Portable Model that Represents Tendencies of Some Elements to Accept or Donate Electrons (MEB, 2008: 56)	7
8	3-D Demonstration of Atomic Electrons, Protons and Neutrons (MEB, 2008: 61)	8
9	3-D Portable Model of Matter's Granular Structure (MEB, 2008: 35)	9

(yellow, green, blue), 1 adhesive, printouts required for calendar pages.

In the preparation of the Material 2;

- *Plastic bottle caps, plastic dishpan pads, light bulbs for visual effects, plastic-covered wire and button*, low-voltage electricity transformer, construction paper.

In the preparation of the Material 3;

- *Plastic-covered adhesive paper* over Styrofoam for the base, cloth pins for the train, *plastic boxes*, fibre chains, *plastic fasteners, coloured plastic bag*, thread, small light bulbs (yellow, green, red), *plastic electricity switches*, copper wires, letters made of small wooden parts for the name of the toy train.

In the preparation of the Material 4;

- Plastic-covered copper wire, *plastic shoebox, plastic button,* printouts of onion-soap-salt pictures, construction paper, adhesive, blue and red light bulbs.

In the preparation of the Material 5;

- Key, plastic-covered copper wire, Styrofoam, led light, *demijohn cap*, foam, shoebox, adhesive, *plastic band*.

In the preparation of the Material 6;

- *Thick plastic, Styrofoam, demijohn cap*, led light, key, *plastic pipe*, adaptor.

In the preparation of the Material 7;

- Foam, red lamps, yellow lamps, Styrofoam, *plastic button*, plastic-covered copper wire, adaptor, toothpicks.

In the preparation of the Material 8;

- Foams used for heat insulation of buildings, lamp, cable, battery.

In the preparation of the Material 9;

- *Dishpan base*, foam, led light, *plastic button*, adaptor, plastic-covered copper wire etc.

Method used during the execution of the project

Theproject method and Yanpar's (2007) material development principles were used.

Execution stages of the project

Materials on the subjects specified in Table 1 were developed by each student in 14 weeks.

1st week, subjects were scanned on textbooks,
2nd week, it was determined whether an activity is recommended in the textbook on these subjects,
3rd week, subjects to work on were defined,
4th week, in-class discussion was organized on the design of the material,
5th week, area expert's opinion was taken on the design of the material,
6th week, education expert's opinion was taken on the design of the material,
7th week, parents' opinions were taken on the design of the material,
8th week, it was discussed in the classroom whether the materials to be used in the design are simple and cheap everyday things,
9th week, it was discussed in the classroom whether these materials are used by other students in the globalized world,
10th week, it was discussed in the classroom whether the students would carry out the projects or not,
11th week, material design started,
12th week, material design continued,
13th week, material design ended,
14th week, the design was assessed with respect to Yanpar's (2007) 6th and 9th principles.

Conclusion and Suggestions

Simple and cheap materials that can be found everywhere and materials polluting the environment were turned into teaching materials. Thus, in the "This is My Work" project format, students were suggested that they can both prevent environmental pollution and contribute to their learning needs simultaneously.

Limitations

The study was limited to the course "Instructional Technologies and Material Design" and 9 students attending the Department of Chemistry at Ahi Evran University in 2011 to 2012.

DISCUSSION AND CONCLUSIONS

As shown in Table 1, a total of nine "This is My Work" project materials have been developed for the subjects of the 9^{th} to 11^{th} grades Chemistry course. Of the materials; 3, 5, 6, 7, 8 and 9 are about 9^{th} grade Chemistry subjects; 1 and 2 are about 10^{th} grade Chemistry subjects; and 4 is about 11^{th} grade Chemistry subjects.

In the end, 9 materials were developed, which could be linked with the learner's need, which was aimed at accomplishing the listed objectives, and which fitted to the "This is My Work" project format:

- Materials numbered 3, 5, 6, 7, 8 and 9 are on 9^{th} grade Chemistry subjects;
- Materials numbered 1 and 2 are on 10^{th} grade Chemistry subjects;
- Material numbered 4 is on 11^{th} grade Chemistry subjects.

It was determined that "the recommended teaching materials do not allow students to practice and experience" in the above-mentioned course books (MEB, 2008, 2010, 2011). This is in contradiction to the 6^{th} material preparation principle of Yanpar (2007). According to this principle, "the teaching material should allow students to practice and experience".

In the study, nine materials in the "This is My Work" project format about 9^{th} to 11^{th} grade Chemistry subjects were developed. As a result, the learner's "learning need" was satisfied, and while satisfying this need, solid-waste plastic materials that pollute the environment –*plastic bottle caps, plastic dishpan bases, plastic buttons, plastic boxes, coloured plastic bags, plastic shoeboxes, demijohn caps, plastic bands, thick plastic, plastic pipes etc.*- were recycled. Thus, the idea expressed by Karl Popper that "all life is problem solving" (HPÇ) was attempted to be realized.

Moreover, taking these materials into consideration, students in all parts of our global village could be assigned with project assignments in which they are required to use cheap and simple daily-life materials and materials that pollute the environment. This way, the learner becomes aware of the importance of his/her own act of learning and thus satisfies his/her learning need. In other words, this need is satisfied through the translation of the subject into the language that students can understand without causing any misconceptions (Shulman, 1986, 1987 quoted in Graf et al., 2011). By satisfying this need, the gap between a student's existing skills and the skills that she is expected to acquire at the end of the course is closed (Ülgen, 1994: 183). This way, the individual becomes aware of her own effort with an independent motivation (van den Broeck et al., 2011: 616).

Besides, while closing this gap, questioning-researching activities, which is a special teaching format which allows students not only to learn science but also to do science, can be developed. Without such activities, it is highly difficult, if not impossible, for students to comprehend the nature of science, to develop cognitive, scientific and technical skills regarding doing science, and to construct important scientific ideas (MEB, 2004: 11). Such high-level mental processes can be used in designing (MEB, 2006: 3-4).

Suggestions

As a result; 9 materials were developed, that can be related to learner's "learning needs", aims to achieve the listed goals, and proper to the format of the "This is my Work" project.

Authors of the mentioned books might be suggested to take into consideration these materials while revising their books. The photographs of the materials are presented in Appendix 1 to 9.

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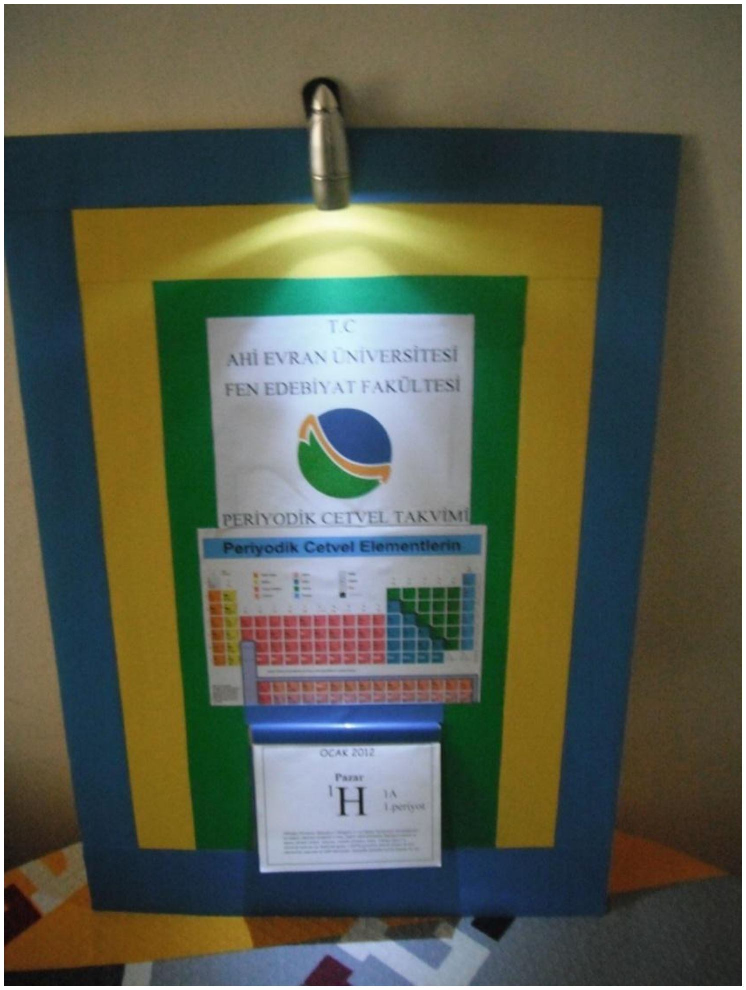
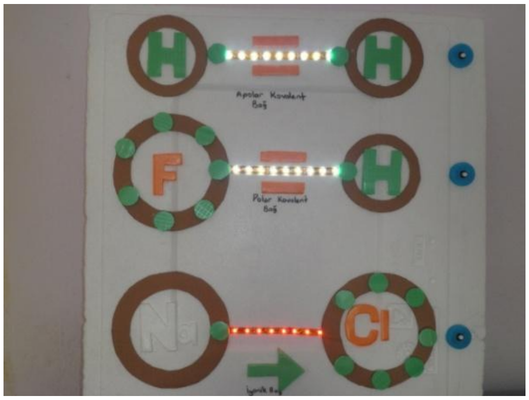


Appendix 1. Periodic Table Calendar.

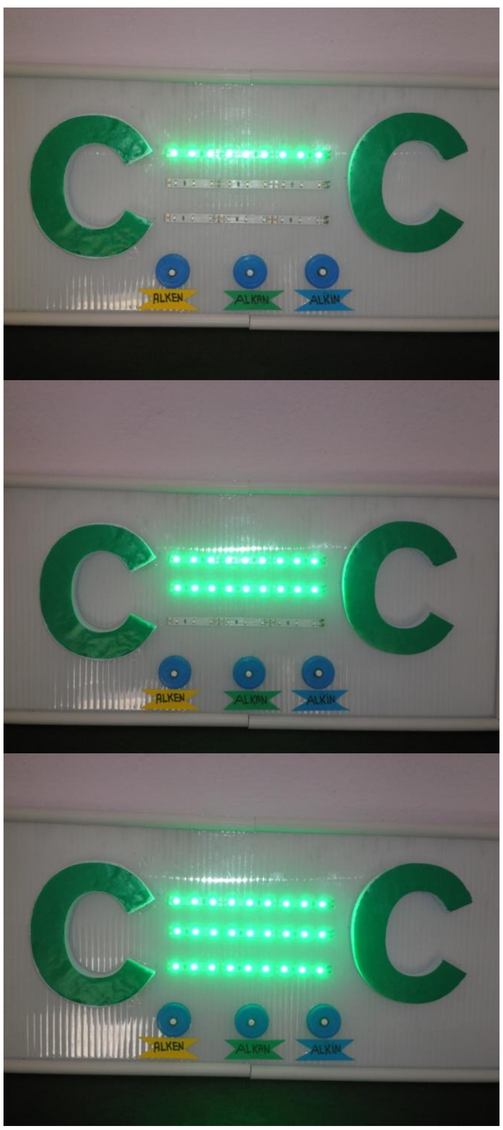
Appendix 2. Demonstration of the relationship between electron affinities and atomic diameter of 7A elements of F, Cl, Br and I.

Appendix 3. 3-D demonstration of the concept of polymer.

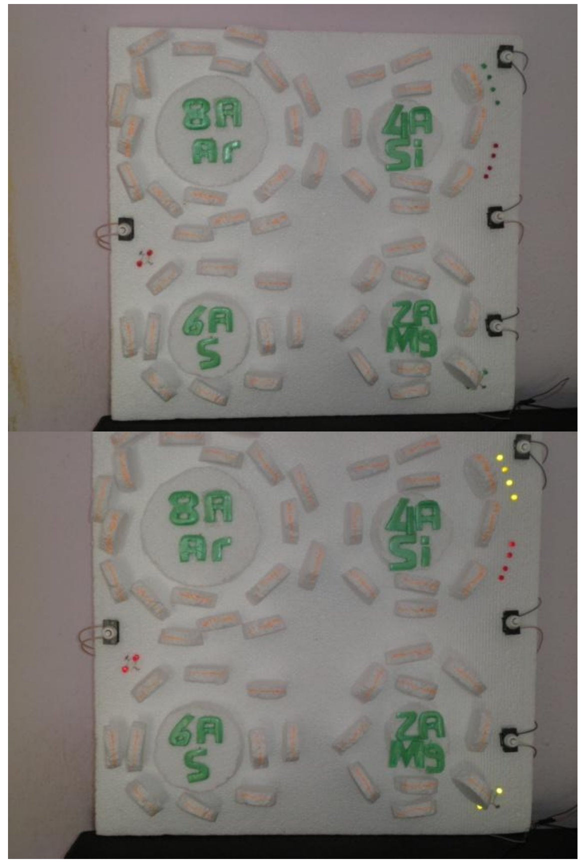
Appendix 4. Demonstration of the intervals where pH is acidic, basic and neutral through a Portable Pepper-Soap-Salt Model.



Appendix 5. 3-D demonstration of chemical bonds.

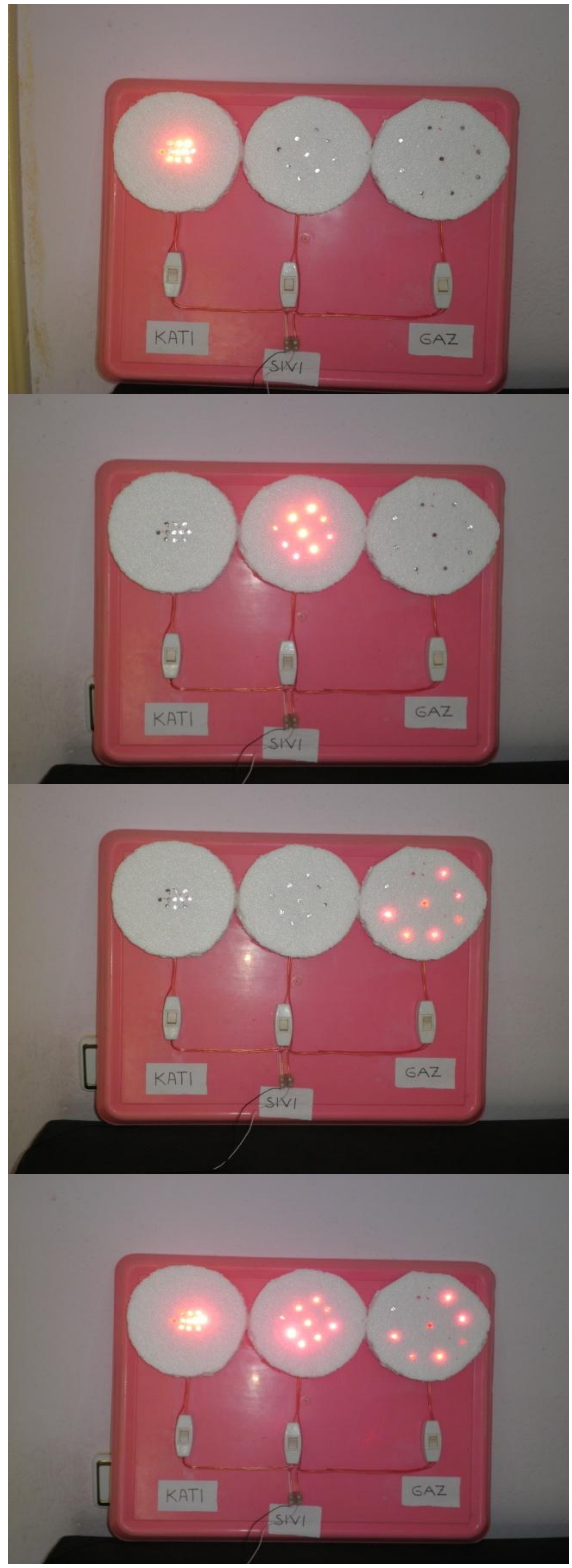


Appendix 6. Lightened 3-D Portable Model of saturated and unsaturated hydrocarbons.



Appendix 7. Lightened Portable model that represents tendencies of some elements to accept or donate electrons.

Appendix 8. 3-D demonstration of atomic electrons, protons and neutrons.



Appendix 9. 3-D Portable model of matter's granular structure.