

Effects of computer supported instructional material (CSIM) in removing students misconceptions about concepts: “Light, light source and seeing”

Salih Cepni*

Karadeniz Technical University, Fatih Faculty of Education, Elementary Education Department, Trabzon, Turkey

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Abstract

This study has three aims; (1) to determine primary school 4th grade students’ alternative concepts about light, light source and seeing concepts in science and technology program, (2) to prepare a computer supported instructional material (CSIM) for these concepts and (3) to determine the effectiveness of this material in removing misconceptions. To determine students’ pre-knowledge, a questionnaire which includes two open-ended questions and a grid applied to students. It was determined that students have the same alternative conception as in the literature. An alternative computer supported material to traditional instructional material was developed and applied for the purpose of removing the alternative concepts and to introduce light sources. After the application of computer supported material, the questionnaire was again applied to the same sample. Data provided from pre-test and post-test are compared and effectiveness of computer supported material in removing the misconceptions were discussed in the paper.

Keywords: Computer; Alternative concept; Light; Light source; Seeing

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*Corresponding author. Tel.: +90-462-248-2654, Fax: +90-462-248-7344.
E-mail: cepnisalih@yahoo.com (S. Cepni).

1. Introduction

Students come to classroom with daily life experiences and developing various ideas about scientific subjects [1, 2]. If students' daily life experiences and ideas that they developed about scientific subjects are determined before the courses, efficient and wanted instruction could be carried out and what the students' know correct, wrong, lacking will be easily determined. Courses should be planned according to correct, lacking and wrong concepts and instructional environments should be provided to remove these lacking points. Because of incompleting knowledge and misconceptions, students have learning difficulties and obstacles in scientific understanding [3]. These misconceptions should be determined and displacement should be provided with correct concepts to provide meaningful learning.

Studies done are showing that; students' views are resistant to change and to change scientific concepts with misconceptions is difficult [4, 5, 6]. Students seem to accept the scientific concepts during the teaching process but they turn back to their past concepts after the course [3, 7,8]. These misconceptions are concentrated on subjects as; force and motion [10, 11, 12], light [13, 14, 15], pressure [16, 17], heat and temperature [18, 19], electricity and magnetism [9, 20, 21]. Although there have been many studies in determining the misconceptions [15, 22, 23], there have been a few studies attempting to remove this misconceptions up to now. In our country light concept is first taught at 4th grade according to new science and technology curriculum, and is expanded and taught in above classes [24]. If the misconceptions about light concepts are not corrected in 4th grade, students will carry these misconceptions to upper grades. Because of this fact, to determine the misconceptions are not enough, nowadays it becomes more crucial to find effective ways removing these misconceptions.

One of the alternatives ways for removing misconceptions is using computer supported instructional materials (CSIM) in classroom environment [4, 25, 26, 42, 43]. CSIM provides students to learn with their speeds, facilitate learning, and gives opportunities to repeat the course contents out of school. Courses handled with CSIM should be supported with pictures, videos, virtual experiment environments, animations, etc., [44, 45, 46, 47]. Utilizing computers in classrooms have also effects on students' effective learning. But, many researches showed that CSIM have not been used sufficiently in schools as a teaching and learning tool. Teachers should be informed about the importance of using CSIM [40 in cited by 41]. The Ministry of Education in Turkey provided laptops under "The National Education Portal Project" for teachers to increase their computer usages in 2005 [41]. Their aims were to provide teachers to meet with computers more and to use them more confidently.

In addition to this, the Science and Technology Curriculum Programs' application process is new for science teachers. Therefore, they need new sources or supporting materials to provide effective instruction in their classroom as they wanted. It should be noticed that guided materials should be prepared to fit the learning theories and the nature of the new programme [27, 28].

2. Purpose

The purpose of this study is to determine students' misconceptions, to prepare a computer supported material (CSM) and to determine effectiveness of this material on changing the misconceptions about light, light source and seeing concepts at 4th grade primary school science and technology instruction program.

3. Method

A mixed research method designed was used for data collections. At the beginning of the study, students' pre- knowledge was determined about light, light source and seeing concepts and then a computer supported material was prepared covering these concepts. Flash MX 2004, Photoshop and Paint programs were used in preparation, application and evaluation of computer supported materials. The below steps are followed to prepare computer supported instruction material:

1. 4th grade students pre-knowledge and misconceptions in literature were determined.
2. Subject titles, aids and scientific process skills which are going to be used in computer supported science and technology instructional material are determined from primary school 4th grade science and technology program.
3. Animations which can be made with flash MX 2004 were designed.
4. Teaching methods and knowledge which was going to be given with animations in computer supported material were determined.
5. Prepared science and technology instructional design was applied in computer environment.
6. Lecturer comment was taken for the developed material.
7. Developed material was applied to 4th grade students in a pilot study.
8. Last position was given with the proof of material (An Example of Screen Views of Computer Supported Instruction Material was given in the appendix).

Then a model with pre test- post test of pre-experimental design was used to observe effectiveness of computer supported material on removing students' misconceptions. In this model variable was measured before and after the application; it means a variable was compared with itself [29, 30]. The study was conducted with 34 students studied in a primary school in Akçaabat, in Trabzon in 2006- 2007 academic year.

A questionnaire consisting of two open-ended questions (appendix 2) and a two-step grid (appendix1) was applied to the sample before and after instruction. Data obtained from the research were analyzed qualitatively and quantitatively. Students' views and misconceptions about light and seeing concepts were determined with open-ended questions. Content analyze was made with the data obtained from open-ended questions. Students repeated answers about light and seeing concepts were frequented. Students' concepts from pre-test and post-test were given in the Tables 2 and 3. Data given from pre-test were written as a normal still size; from post-test were written as an italic size. Codes of each student and students' views were also given in the Tables 2 and 3.

Two-step grid was formed with twelve pictures which were about light source or not (see Appendix 1). At the first step students were wanted to select the picture about question and at the second step students were wanted to explain their reasons about their selections. In general, analyze of data from the grid can be made; a) students were wanted to find appreciate picture, b) organize these box numbers according to rational and functional order. Different grade system was used for each step [24, 31].

Categories in Table 1 were formed with the analyze method developed by Abraham et al. [31] and Haidar and Abraham [32].

Table 1. Contractions and expansions used in data tables.

Correct Choice - Correct Explanation	CC-CE
Correct Choice - Partially Correct Explanation	CC-PCA
Correct Choice – Explanation Including Alternative Concept	CC-EIAC
Correct Choice – No Answer, Unrelated Explanation	CC-E
Incorrect Choice- Correct Explanation	IC-CE
Incorrect Choice - Partially Correct Explanation	IC-PCA
Incorrect Choice - Explanation Including Alternative Concept	IC-EIAC
Incorrect Choice - No Answer, Unrelated Explanation	IC-E
Correct Explanation	CE
Partially Correct Explanation	PCA
Explanation Including Alternative Concept	EIAC
No Answer, Unrelated Explanation	E-E

Lectures comments were taken for the validity of test questions and the computer supported material. And the material was analyzed by two science and technology teachers, too. The material was also applied to two 4th grade students. In this way, the lack points of the material were completed and final version of the material was implemented (see sample materials at appendix: 4-6)

3. Results

Students' responses were presented below in the Table 2 and 3. Italics writings in the tables were data obtained from post testing "two-tiered grid" and "open-ended questions" were applied to sample before and after the study done with material.

3.1. Findings obtained from two-tiered grid

Students' responses for pre test and post test were presented one by one in the Tables 2 and 3. A different code was given to the each student. Such as; S1 was the code given to first student. While normal writing in tables was presenting responses in pre-testing, italics writing was presenting responses in post testing.

Table 2. Students' views about pictures of light sources

Codes	Students' responses about codes	Pre-testing	Number of person	Post testing	Number of person
CC-CE	Because all of them brighten our environment, light up	S9,	1	S2, S3, S4, S5, S12, S20, S21, S24, S25, S29, S30, S31, S32, S34,	14
	<i>Because they brighten and light up environment</i>				
	<i>Because they have their own light, no other light puts light. For example; diamond ring has no light of its own, it brighten with another light.</i>				
	<i>All of them diffuse its light.</i>				
	It is used to see colors. Especially sun gives light.				
	<i>If things in the picture are not existing, we could not see our foreground</i>				
	<i>I choose the ones above because when light comes, the diamond ring brightens.</i>				

(Table 2)

IC-CE	Because it brightens surroundings with lighting up.	S6, S9, S18, S22, S24, S30, S31, S32,	8	S1, S6, S8, S9, S11, S13, S16, S17, S18, S22,	10
	<p>They are providing brightness with giving light</p> <p>They are all lighting up their surroundings.</p> <p><i>Because these pictures have their own light and they are lighting up their light to us.</i></p> <p><i>They are lighting up surroundings</i></p>				
IC-PCA	<p>Because it provides us to see. Light comes to our eye and we can see</p> <p>They flammable when we are going in dark and provides us to see our foreground</p> <p>For example sun is a light source. Because it is brilliant and sparkle</p> <p>They provide us to see surroundings</p> <p>When electricity cuts off, we burn up electric torch and we enlighten our house</p> <p>When we light a votie candle, it lighten but warning sign doesn't lighten</p>	S2, S4, S8, S11, S13, S14, S15, S17, S20, S26, S27, S28,	12	S28,	1

(Table 2)

	Enlightens somewhere				
	When it is dark head lamp light up the road and driver benefit from it				
	Because we can see our foreground with help of them				
IC-EIAC	Because they are brilliant	S1, S16, S21, S25, S33,	5	S7, S10, S15, S23, S26,	5
	Light source is a yellow matter which enlightens room				
	They reflect light				
	Candles rope is made of gas, I suppose that firefly has battery; when we put battery to the electric torch it gives light. When we put lamp into electric it gives light				
	They are all energy				
	<i>As they didn't get light (sun and firefly)</i>				
	<i>They are not man made things (thunderbolt, sun, firefly)</i>				
<i>They emit light by themselves</i>					
IC-E	When we enter into a cave and if the cave is dark how could we go in? For this reason there must be light source.	S3, S7, S10, S12, S19, S23, S34,	7	S19, S27	2
	Because it gives color				
	Light torch work with battery, candle is nonflammable without flame, lamp works with electricity, sun difuses light in the daytime				
	<i>Light source is a light</i>				

In pre-test just one student was stated in “CC-CE” category. In post-test fourteen students were stated in this category. Twelve of the students stated in “CC-PCA” category in pre-test, in post test only one student stated in this category. Student number in “Incorrect Choice - Explanation Including Alternative Concept” category was same in pre test and in post test.

Table 3. Students’ views about pictures which are not light source

Codes	Students’ responses about codes	Pre-testing	Number of person	Post testing	Number of person
CC-CE	<i>They don’t emit light, they reflect it</i>			S5, S12,	14
	<i>When we put electric torch or light source on them they reflect light</i>			S14, S20,	
	<i>When light comes through these picture, they reflect on us. And we suppose them as light source</i>			S21, S24,	
	<i>When we use them we understood that all of them are not giving light</i>			S25, S26,	
	<i>They don’t reflect light to us because they don’t have light</i>			S29, S30,	
	<i>They are taking their light from light sources</i>			S31, S32,	
	<i>Because they could not emit anywhere</i>			S33, S34,	
	<i>They don’t have their own light, they become brilliant when light comes on them</i>				

(Table 3)

CC-PCA	<p>We stayed in dark with them. They don't give life.</p> <p><i>Because when light comes over them they diffuse light</i></p> <p><i>They are not diffusing their light, they are diffusing the light which they take from other things</i></p>	S5,	1	S2, S4,	2
IC-CE	<p>Because warning sign can't be a light source. When we went to a cave and take it in our hands, it couldn't show us anywhere</p> <p>If we take diamond ring and hold it to the road it won't give light.</p> <p>It is not brightening us with giving light.</p> <p>They are not emitting light</p> <p>None of them is emitting light. They are just giving light to us and helping us to see</p> <p><i>Don't emit light</i></p> <p><i>They reflect light when light comes on them</i></p>	S3, S20, S22, S24, S28, S29, S30, S31,	8	S3, S6, S8, S10, S11, S13, S17, S22,	8
IC-PCA	<p>Because they can't brighten surroundings</p> <p>Because there is no light on them. We can't see our foreground with them</p>	S4, S13, S14, S17, S34	5	S28,	1

(Table 3)

	Because it is said in the question to write the ones which don't give light				
IC-EIAC	Because they don't reflect light with sparkling	S1, S2, S8, S11, S12, S15, S18, S26, S32, S33,	10	S1, S15	2
	Because they are not showing their light in everywhere, everytime. For example head lamp is sufficient at home and in classroom				
	They are not blinding and brilliant				
	They are not so much lightened things				
	Because they don't reflect light				
	They don't light up one place completely				
	They are not emitting. Some of them emits light but they couldn't be light source				
	Fork, spoon, warning sign doesn't light because of it I think that they are not light source				
	<i>Because things in these pictures don't have their own light</i>				
	<i>When we put light on them they seem as a light source. But if they spread light by themselves they could be called as light source</i>				

(Table 3)

IC-E	Because they don't give color	S6, S7, S19, S21, S23, S27,	6	S7, S16, S18, S19, S23, S27,	6
	<i>They give light to surroundings from another light source</i>				
	<i>Because they are taking light from others</i>				
	<i>Because they are not spreading light</i>				
E-E	For example warning sign is not related with light	S9, S10, S16, S25,	4	S9,	1
	Some matters don't extract yellow light				
	<i>They emit light</i>				

None of the students stated in "CC-CE" category in pre-test. Fourteen students stated in this category in post-test. Ten students stated in "Incorrect Choice - Explanation Including Alternative Concept" in pre-test and two students stated in this category in post-test.

1. Findings Obtained From the Open- Ended Questions

Students wrote their explanations about light concept in the Table 4. Students respondes in using concepts as; equipment, firefly, thunderbolt, light source, star, energy concepts increased in the post-test.

Table 4. Students' views about light concept

Concepts	Pre-test (f) (N=34)	Post-test (f) (N=34)
Sun	19	14
Moon	6	2
Equipment (floor lamp, bulb, electric torch, candle, etc.)	2	19
Fire	5	5
Firefly	3	8
Thunderbolt	2	4
Person found the light	1	-
Lightning	16	9
Brilliance	1	-
Light source	2	13
Seeing	3	-
Color	6	-
Electricity	3	-
Star	1	5
Energy	2	6
Light pollution	-	1
Light diversity	-	1
Beacon	-	2

Table 5. Students' views about seeing concept

Main concepts	Students views	Pre-test	Percentage	Post- test	Percentage
Unrelated responds about seeing	Snowwhite like water	S1, S5, S8, S9, S11, S12, S19, S24, S28, S32	10	S5, S7, S10, S11, S23, S33	6
	You see colors aplenty				
	We see light brillant				
	Sun appears in the mornings, it is dangerous to look at it as its light is much. But we can look at it with sunglasses.				
	We can see while not sleeping				

(Table 5)

	Bright				
	As I am not blind				
	Everthing has its own figure and color and we see them				
	<i>I can see colored</i>				
	<i>If light comes from the other side I can see</i>				
	<i>With the help of natural and artificial matters</i>				
	<i>Bright, white, yellow</i>				
	<i>Light lighten everywhere. fluorescent lamp and sun lightens and warm up us</i>				
Light	When light comes across our eye we can see the matter across us	S2, S4, S6, S13, S14, S15, S20, S22, S27, S33, S34	11	S1, S2, S3, S4, S12, S14, S16, S17, S18, S20, S21, S24, S25, S28, S29, S30, S32, S34	18
	We can see the places which are euphotic				
	Light is in every color. Light is important for us but when we looked at it too much our eyes stream.				
	We can see by means of eye				
	We can see when lamp light up and sun disperse energy to surroundings				

(Table 5)

	<p>We open the light when it is dark, put lights and we can see</p> <p><i>I can see the matters which emit light</i></p> <p><i>When I see much light my eye be dazzled</i></p> <p><i>By means of light as it is an energy</i></p> <p><i>As natural and artificial light source illuminates surroundings</i></p> <p><i>To see everything light is needed. We can't see anything without light</i></p> <p><i>Light types are coming to my mind.</i></p> <p><i>Electric torch, candle, sun etc. reflects light. And we can see by means of them</i></p> <p><i>Light is reflected</i></p> <p><i>We can see by means of light sources.</i></p> <p><i>We can light up the lamp look at it and see</i></p>				
Brightness	When the electricity cut we can use the electric torch and it illuminates surroundings	S3, S10, S16, S18	4	S26	1
Eye	We see with our eyes	S7, S23, S25, S29, S31	5	S6, S15, S22, S31	4

(Table 5)

	Our pupil transfer image of matter to our brain. Brain finds out what is it from the memory and we can see like that. If there is no liight we can't see, we see everywhere black				
	We see light by means of our eyes <i>We can see with our member eye. We can't see our foreground when it is dark. But we can see everything which are white</i>				
Color	Light coming from sun are coming to matters and we can see the color which is coming through We can see by means of color particles <i>I can see colorful</i>	S17,S30	2	S9	1
To look	We couldn't look at the light as it is too much. But floor lamp isn't like that we can look at its' light very easily	S21	1	-	-
Seeing	<i>We see dark when we are in a dark place, and bright when we are in a lightened place</i>	-	-	S8, S13, S19, S27	4

(Table 5)

Sun	<i>We see better because we couldn't be illuminated when there is no light</i>				
Equipment	<i>By candle, electricak torch, lamp, cresset and headlamp</i>				
Empty		S26	1	-	-

Eleven students in pre test and eighteen students' in post test related concept seeing with light.

4. Discussion

Discussions about the data obtained from students' responds in "two-tiered grid" and "open-ended questions" were given below.

4. 1. Students' views about the pictures of the light sources and their justifications

An increase at "CC-CE" category concering light sources was observed in post test. It comes from the fact that students made a connection between light sources and their reasons of being a light source after the instruction. There is also an increase in students' selection of "CC" category and explanation of "PCE" in post test. They explained their reasons for being a light source associated with seeing. It could be said that the activities in the CBIM about seeing were efficient in this association.

Students' number who selected "IC" category and could write correct explanation increased after the application of the CBIM. But surprisingly students' number who selected "IC" and write "PCE" was more in pre-test.

Students' numbers in pre-test and post- test in "IC - EIAC" category were same but their explanations have changed from brightness, yellow matter to natural and artificial light sources in post- test. Besides, students' accepted natural light sources as light source but they refused artificial light sources. With the analysis of the post test results, it was noticed that the CBIM contributed students in developing concepts differently. This shows that students haven't constructed natural and artificial light source concepts completely. This situation can be explained as, every student can't learn same it doesn't matter how well the instruction is [34]. .

4. 1. Students' views about pictures of not light sources and their justifications

There isn't any student in "CC – CE" category in pre-test but their percentage increased to 41,1% in post-test. This shows that after the CBIM implementation, students' knowledge and understanding increased related to the not light sources. This finding supported the studies [48, 49] which argued that computer supported materials have positive influences on conceptual understanding, conceptual changes and improvement of scientific reasoning skills. When their reasons were examined S5's explanation as "They don't emit light, they reflect it" was remarkable. This showed that students understand the differences between diffusion and reflection of light. Researchers find out that students' have various misconceptions about reflection [35, 36]. So students' differentiation of diffusion and reflection concepts was very important.

There was no important difference between pre-test and post-test about “CC- PCE” category. S5’s respond was placed in “PCE” category in pre-test, it is placed “CC - CE” category in post-test. S2 passed from “IC- EIAC” category to “CC-PCE”category. As considered that misconceptions resist on conceptual change, we can say that applied computer supported instructional material was efficient in conceptual development of this student. This student could remove his misconception and could give the correct respond to the question. As seen from the other studies done in other areas, computer supported instructional materials were effective in removing misconceptions [27, 37, 38, 39, 50].

There was no increase in “IC- CE” category in pre-test and post-test. But some changes were seen in students’ explanations. In pre-test students explained their reasons with their daily experiences (*for example; if we take the diamond ring and walk with it at night it won’t give light*). But in post-test they explained their reasons correctly with their experiences from the material (*for example; when light comes on them they reflect it*).

There are five students in pre-test and one student in post-test in “ICC- PCE” category. That student (S28) was in the “IC- CC” category in pre-test. He explained his reason as “it doesn’t enlight environment” in pre- test and explained his reason in post test as “it doesn’t provide seeing”.

29,4% of the students’ were found in “IC - EIAC” category in pre-test. This percentage decreased to 5, 8% in post-test. S1 and S15 were in the same category in pre-test and in post-test. This situation could be interpreted as; misconceptions resist on change [4, 7].

Students’ percentages in “IC - E” category were same in pre-test and in post-test. S7, S23, S27 gave the same answers in pre-test and in post-test but the others transmitted to a different category. This situation could be explained as; these students couldn’t understand and construct the experimental environments

provided with computer supported material. Because these students explained their reasons for choosing the pictures as; “they are giving light to surroundings from another light source”. Students’ couldn’t understand the fact that; they reflect the light which they took from light source and they seen as emitting light. Students placed in pre-test in this category explained their reasons as; “*Because they don’t give light*”.

There was an increase in “No Answer, Unrelated Explanation” category. Only one of the students stayed in this category in post-test. S25 passed through to “CC - CE” category; S1, S16 passed through to “CC – E” category.

4. 3. Students views about light source

Students’ concepts and their percentages used in explaining light concept were seen in Table 4. There was an increase seen in students’ usage of concepts like equipment, firefly, thunderbolt, light source, star and energy in explanations of light concept, post-test. The reason of this increase can be told as; there were various technological equipments, explanations about how a firefly was a light source, activities one-to-one interacting with light sources in the applied material. And also students used concepts like light pollution, light types and lighthouse in post-test which weren’t used in pre-test. This situation could be explained with; by computer supported material students had opportunity to come across with activities more then one like; experiment, reading and asking and this increases students’ learning.

4. 4. Students’ views about the concept seeing

Besides giving non related answers, students used light, illumination, eye,

color, to look at, to see, sun and equipment concept while explaining “seeing” concept. It was not waited from students’ to explain “how does seeing case come true?” correctly. Because students’ haven’t taught reflection in 4th grade, they will study reflection concept in further grades. Students’ awareness about to see in dark without light was tried to determine with this question. 29,4% of the students were giving unrelated responds before the application, this percentage decreases to 17,6% in post-test. There was an increase in students’ usage of “light” concept in explanation of seeing concept. This results could be interpreted as; computer supported materials were effective in students ability in scientific expression.

There was not so much difference in students’ usage of eye concepts in explaining “seeing” concept. Students express that eye was active to see events. Similar data was come across in researches done before [35].

5,8 % of the students in pre-test and 2,9% of the students in post-test associated seeing with color; stated that they see with color particles. S21 associated “seeing” and “to look” concepts in pre-test. It has seen in literature that students assess “seeing” and “to look” concepts as the same [13, 36]. After the application S21 stated that he could see with light, it is impossible to see without light.

Some students expressed in post-test that they see dark, in dark place and bright in lighten place. Students stated that bright environment was provided with sun and they could see by this way. They also stated that other illumination equipments were providing to see. In their studies [35] determined that students’ think that they could see everything which was bright. S26 didn’t answer this question in pre-test but in post test he assumed that he could see if brightness was provided. When students’ responds were examined before and after practice it was seen that computer supported instructional material was efficient in

students' conceptual change and development.

5. Conclusion

Conclusions about the data obtained from discussion are given below:

1. Students' views about pictures of the light sources and conclusions about their justifications:

Activities in the CBIM were effective in construction of concepts as identifying light source and explaining reasons for being a light source in students mind. Although students' alternative concepts changed with the activities in the CBIM, it has seen that some of the students' alternative concepts were resistant to change.

2. Students' views about pictures of the not light sources and conclusions about their justifications:

Computer supported instruction material was effective for students' determination of the material that weren't light source and was also effective in explaining their reasons.

Activities in computer supported instruction material were also effective for removing students' alternative concepts and reaching the scientific knowledge. Computer supported instruction material gave feeling to students to explain the related concept scientifically and was contribute to develop students' scientific thinking skills.

Computer supported instruction material contribute to develop scientific thinking skills of some of the students but sometimes it has not positive contribution to some students. This situation was one of the results of students learning in different method and strategies. Computer supported instruction material was effective in providing conceptual change.

3. Conclusions about students views about light source;

Students' views about light concept changed in a positive way and showed variety with application of computer supported material. Multiple learning environments were provided to students by computer supported material.

4. Students' views about the concept seeing

Students' rate of relating "seeing" concept with "light" concept increased after the application of computer supported instruction material. Unrelated responds rate was decreased. Some students couldn't remove their alternative concepts about the concept "seeing".

When students knowledge related to concepts "light, light source and seeing" were examined before and after application of computer supported material; it has seen that material is effective in students conceptual change and development.

Some of the students were able to remove their alternative concepts but some were not. This situation was a result of resistance of alternative conceptions to change. And it has also seen that some of the students construct new misconceptions and wrong knowledges in their mind. Students have difficulties in changing their existing knowledge with new ones because of the fact that new one does not make any sense for them.

In summary; the CBIM is an alternative way for students' learning, every student has their own learning style, although the CBIM is thought as an effective teaching tool, every individual can't get desired learning outcomes or benefits at the same level.

6. Recommendation

In this section suggestions are given to teachers, students and researchers about computer supported material and its usage:

1. Students' can have deep knowledge about the topic by using computer supported instruction materials with practice.
2. Teacher should try to find out their students' pre-knowledge about the topic before instruction. They can use conceptual tests which are applied before and can also use techniques as; prediction-observation-explanation, drawings, interview about concepts. By the teachers become aware of what do their students know or not and they can design instructional activities and can prepare more effective learning environments to them.
3. Preparation of computer supported instructional material is a time-consuming work so education researchers could develop computer supported instruction material in various concept and subjects.
4. If education researchers give attention to the samples probable alternative concepts when developing material, they will make more effective studies with their materials in removing alternative concepts.
5. Activities that students could make by themselves should be put into computer supported instruction materials
6. Activities that are prepared in computer should be thought as alternative not as center of learning. Activities prepared in computer should be supported with other instruction materials and courses should be carried on multiple learning environments as: concept maps, animations, drawings, worksheets, conceptual change texts, models.

7. Teachers should have alternative methods for teaching a subject. Because not all of the students are learning at the same way. Their pre-knowledges, misconceptions and understandings about the subjects may be different, just CBIM would not be enough to teach the topic. So teachers could have to teach in different ways, with different equipments.
8. Some more activities or explanations could be put on the CBIM material to remove students' misconceptions about the concept "seeing" and to obstruct new misconceptions and wrong knowledges.

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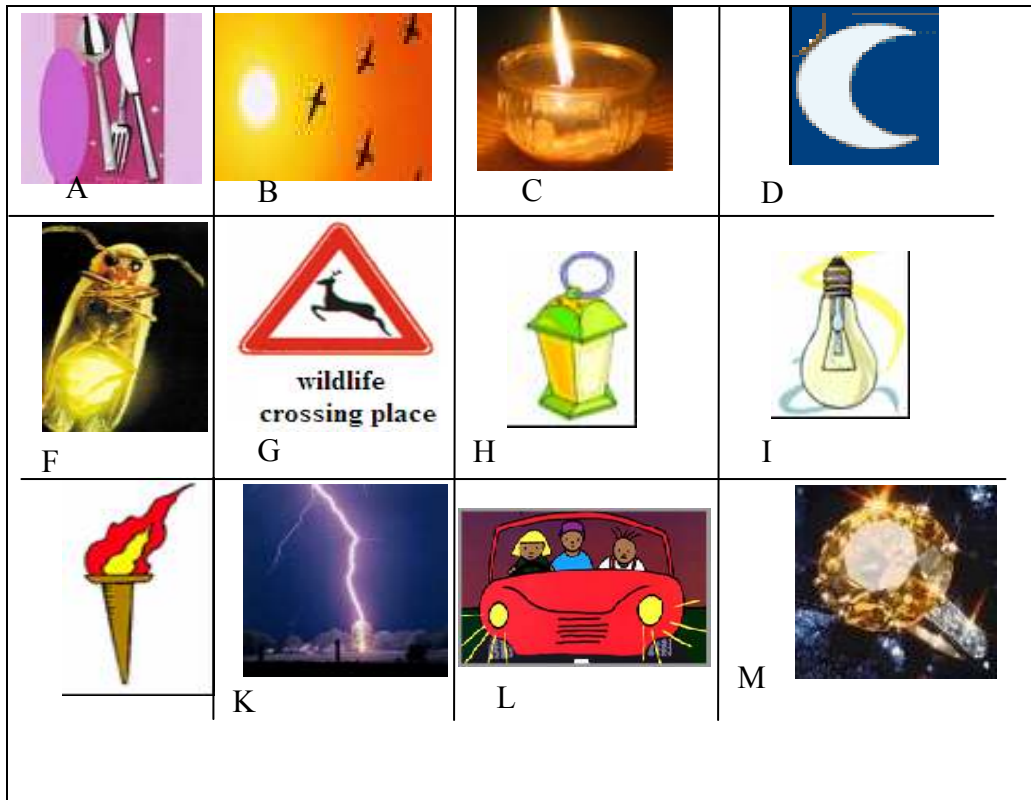
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Appendix- 1: GRID What Do You Know?

1. Examine carefully the pictures below.



1. a) Which one or ones of the pictures are light source? Write below.

b) Why do you think those pictures are light source? Explain it.

2. a) Which one or ones of the pictures are not light source? Write below.

b) Why do you think those pictures are not light source? Explain it.

Appendix-2: Open-Ended Questions

1. What do you think about the word light? Write below.
2. How could we see? Explain it.

Appendix-3: EK-3: Screen Views of Computer Supported Instruction Material

An Example of screen views

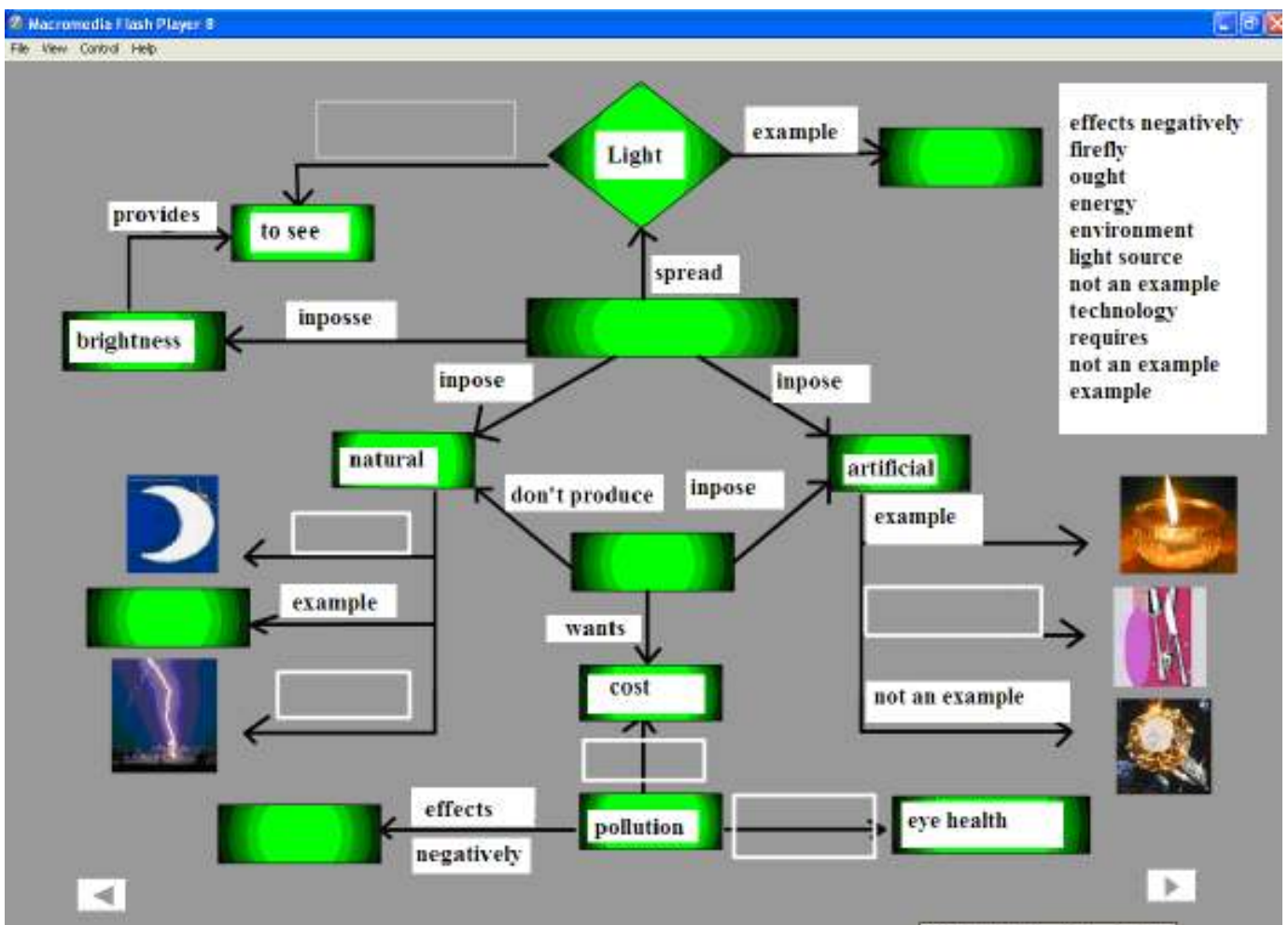


Fig. 1. Concept map of the light concept.

The screenshot shows a Macromedia Flash Player window with a grey background. At the top, a white box contains the question: "Which can be a light source?". Below this, another white box asks: "Could you give examples to light sources? Write your examples to the cartridges in the concept network". The central part of the screen features a concept network diagram. A central white box labeled "LIGHT SOURCES" has eight arrows pointing outwards to eight empty rectangular boxes (cartridges) arranged in two columns of four. At the bottom left and right corners of the player, there are navigation buttons: a left-pointing arrow and a right-pointing arrow, respectively.

Appendix 4: A brain storm activity.

Appendix-5

1. Screen views about application of science and technology instruction design in computer environment.



Fig. 3. Case for not seeing.

Appendix-6

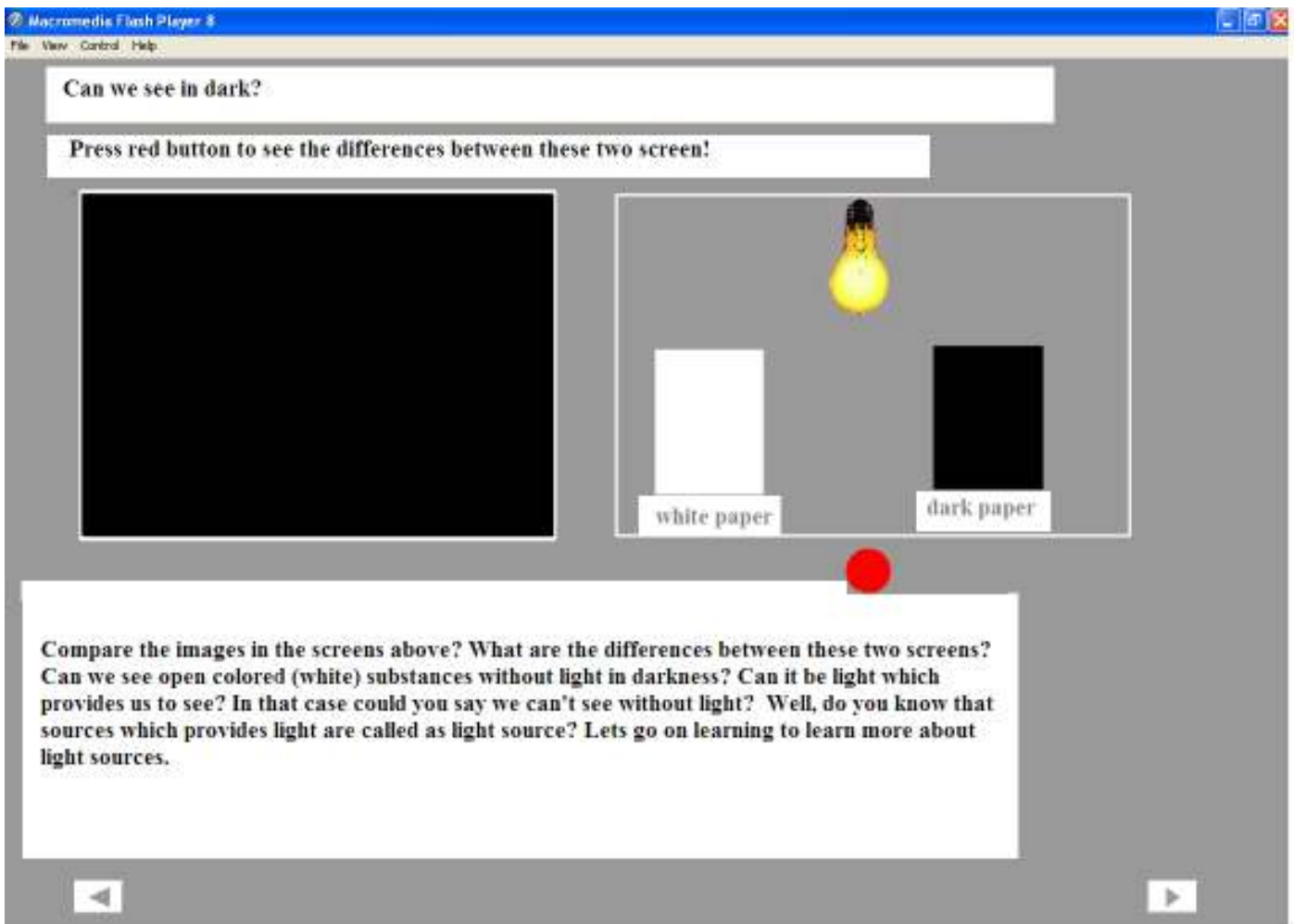


Fig. 4. Case for seeing.