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What Makes Concept Cartoons More Effective? Using Research to Inform Practice

Kavram Karikatürlerinin Etkililiğini Nasıl Artırabiliriz? Uygulamayı Etkin Kılma Noktasında Araştırmadan Yararlanma

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Abstract

The purpose of the present study is to propose several ways of making concept cartoons more effective and to find out their effectiveness of concept cartoons on learning. Both case study and pre and post experimental research designs were used. The main data sources were written feedback form collected from the learners, field notes concerning classroom observations and videotape recordings of the instruction. Findings of the study indicated that concept cartoons in form of worksheets are as effective as posters in remedying students' misconceptions and helping them to understand scientific ideas. They also indicated that cartoon characters do not cause change in students' response pattern while minimizing classroom management problems during whole class reflection activity.

Keywords: Science Education, Concept cartoon, Design, Teaching, Constructivism

Öz

Bu çalışmada, kavram karikatürlerinin sınıf içi kullanımındaki etkililiğini artıracağı düşünülen bazı özellikler öne sürülmüş ve bu özelliklerin olası katkıları araştırılmıştır. Araştırmada nitel araştırma desenlerinden durum çalışması ile nicel araştırma desenlerinden öntest-sontest deneysel model kullanılmıştır. Araştırma bir ilköğretim okulundan seçilen ilköğretim 4 ve 5. sınıflarla gerçekleştirilmiştir. Araştırmanın temel veri toplama araçları kavram karikatürü şeklindeki sondaj soruları, araştırmacı notları ve uygulamaların video kayıtlarıdır. Araştırmalardan elde edilen bulgular ışığında çalışma yaprağı şeklinde tasarlanan kavram karikatürlerinin öğrencilerin yanılgılarını gidermede poster tarzındaki kavram karikatürleri kadar etkili olduğu belirlenmiştir. Bulgular ayrıca, karikatürde yer alan karakterlerin isimlendirilmesinin sınıf içi tartışma sırasında sınıf yönetimini ve sınıf içi tartışmanın organizasyonunu kolaylaştırdığını göstermektedir. Karakter isimlerinin öğrencilerin yanıtlarını etkilemediği ve yanıtlarında herhangi bir değişikliğe neden olmadığı da yine araştırma bulgularından çıkan diğer bir sonuçtur.

Anahtar Sözcükler: Fen eğitimi, kavram karikatürü, dizayn, öğretim, yapılandırmacılık.

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Introduction

According to the constructivist view of science learning, students develop ideas or meanings on the base of their existing ideas. Thus, educators emphasise that instruction should be directly based on students' individual ideas (Driver, Asoko, Leach, Mortimer & Scott, 1994; Driver, Guesne & Tiberghien, 1985; Osborne & Freyberg, 1985; Wittrock, 1974). In other words, every student needs to be provided an opportunity to air, debate and investigate her/his own idea to develop a more scientifically acceptable one. Research indicated that this was sometimes unworkable due to classroom management problems (Naylor & Keogh, 1999a; Warwick & Stephenson, 2002). A group of researchers offered the concept cartoon approach as a solution (Keogh & Naylor, 1993; Keogh & Naylor, 1997a; 1997b; Keogh & Naylor, 2000a; Naylor & Keogh, 2000e; 2002). They claimed that teaching via concept cartoons minimizes classroom management problems and provides a manageable way to base teaching directly on individual students' ideas (Keogh & Naylor, 1998; Naylor & McMurdo, 1990). According to these researchers concept cartoon approach minimizes classroom management problems by promoting focused discussion and keeping the children on task.

A series of books have been produced providing teachers with examples of concept cartoons which develop scientific understanding (Naylor &Keogh, 2000a; 2000b; 2000c; 2000d). A series of studies have been conducted to investigate the effectiveness of concept cartoons. Researchers who studied the effectiveness of concept cartoon approach reported that teaching via concept cartoons promotes conceptual change by eluciding misconceptions (Chin & Teou, 2008; Ekici, Ekici & Aydın, 2007; Keogh & Naylor, 2000b; Morris, Merritt, Fairchough, Birrell & Howitt, 2007), supports progression in students' understanding of scientific ideas (Kabapınar, 2005; Keogh & Naylor, 1999; Oluk & Özalp, 2007; Stephenson & Warwick, 2002) and increases enquiry learning skill perceptions (Balım, İnel & Evrekli, 2008). Concept cartoons are also found to be valuable due to their feature of making the situation problematic by showing alternative ways of looking it. In this way, concept cartoons help students to question their thoughts, consider other perspectives which might contradict to their views and solve this problem out (Dabell, 2004; Naylor & Keogh, 1999b).

Concept cartoons are viewed as one of the possible strategies for promoting argumentation (Feasey, 1998; Keogh & Naylor, 1999; Naylor, Downing & Keogh, 2001; Osborne, Erduran & Simon, 2004; Wellington & Osborne, 2001). According to Jimenez-Aleixandre, Rodriguez & Duschl (2000) the lack of agreement amongst characters poses a problem and this problem forms a condition for promoting argumentation. Naylor, Keogh, de Boo & Feasey (2001) identified several aspects of concept cartoons which make them potentially relevant to promoting argumentation in science lessons. They state that concept cartoons legitimise argumentation via the characters, create cognitive conflict by making alternative views plausible to learner and generate a need for justification based on evidence. Naylor, Keogh & Downing (2007) provided evidence to support this theoretically-spoken feature of concept cartoons. In their study, they found that primary school students could co-construct arguments being stimulated via concept cartoons without teacher intervention or any prior training.

Research on concept cartoons also showed that discussion created via concept cartoons is focused and self-sustaining which results in high levels of pupil involvement including those otherwise reluctant to express their personal views (Bandiera & Bruno, 2006; Chambers & Andre, 1997; Keogh, Naylor & Downing, 2003; Naylor, Downing & Keogh, 2001). According to researchers not only concept cartoons' motivating nature but also non-threatening atmosphere make the strategy effective particularly for students who require confidence in putting forward their views in teaching context. Thus, researchers think that concept cartoons are valuable tools to teach learners with special educational needs (Dabell, 2008).

Another advantage of concept cartoons pinpointed by researchers is related to group work and investigation. They put forward that concept cartoons create a real need for investigation

(Chin & Teou, 2008; Keogh & Naylor, 2000b; Morris et al., 2007). Researchers think that even if concept cartoons may not lead to an investigation or practical activity it promotes group work which makes the children working towards the same goal (Keogh & Naylor, 2000b; Keogh, Naylor & Wilson, 1998).

Apart from being an effective teaching strategy, concept cartoons appear to be effective assessment tools in finding out students' alternative ideas (İngeç, 2008; İngeç, Yıldız & Ünlü, 2006; Naylor et al., 2001; Pelaez, Hoover & Treagust, 2004). Researchers provide evidence for accepting concept cartoons as both for formative assessment purposes (Chin & Teou, 2008; Naylor, Keogh & Goldsworthy, 2004) and for summative assessment purposes (Martinez, 2004). Naylor & Keogh (1999b). Such research also reported that concept cartoons are effective ways of exploring not only children's ideas, but also adults' ideas. They displayed concept cartoons in the London undergrounds and found that they are eye-catching means of promoting thinking and discussion. Thus, they suggested that concept cartoons can be benefited in informal learning settings to promote public awareness and understanding of science.

Teachers who used concept cartoon approach in their classes seem to share similar ideas with researchers regarding the advantages of the concept cartoons put forward by the researchers (Keogh & Naylor, 2000b; Long & Marson, 2003). Additionally, they think that concept cartoon approach generate questioning skills in children and promote language and literacy.

As can be deduced from the aforementioned studies, research on concept cartoons falls into two main categories. One of these studies focused upon the utility of concept cartoons in classroom settings and their potential benefits. The second line of research seems to concentrate on concept cartoons' effectiveness by taking the term in a range of different perspectives. Although the pedagogical approach in which concept cartoons embedded differed in these studies, the way they were designed stayed the same. Researchers preferred to adopt the formula provided by concept cartoons creators (Keogh, Naylor & Downing, 2003) in their design, except Dabell's study. Dabell (2008) changed the original structure of concept cartoons by either using two correct ideas on the same concept cartoon or using no incorrect speech bubbles. However, he neither provided suggestions on the design of the original structure of concept cartoons to increase its effectiveness nor compaired the effectiveness of this new with the original one. Empirical research investigating the relationship between the design of the concept cartoons and their effectiveness appear to be lacking in the research literature. Apart from contributing to the related literature, several aspects of such a study are noteworthy. It might encourage researchers to search more effective ways of designing concept cartoons. Also, it illustrates the ways in which concept cartoons might be benefited more and more often by changing its structure. Finally, such a study might open up new trends in educational research, such as adopting new teaching pedagogies to concept cartoons.

Problem Statement

Concept cartoon approach is based on a poster on which alternative ideas are placed together with the scientifically acceptable one, regarding a scientific phenomenon are presented in a form of cartoon-style drawing. In this drawing, made-up cartoon characters air ideas. Concept cartoons then invite the learner to join the debate with the cartoon characters by stating their own ideas. According to Keogh, Naylor & Wilson (1998) so as to possess aforementioned benefits, concept cartoons possess some features. These are; concept cartoons need to have minimal text, need to be used which is in dialogue form, scientific ideas are applied in everyday situations, the alternative viewpoints are selected on the basis of research on students' understanding so that all ideas can be seen as credible by learners, the alternative viewpoints include the scientifically acceptable view and the alternative viewpoints are given equal status so that learners can not work out which alternative is correct from the context.

By acknowledging the importance of these common features, we propose several additional conditions/features that might make concept cartoons more effective by increasing their usability in teaching science. We think that these additional features might make both the preparation

stage of concept cartoons and its usage in crowded science classes easier. Besides, they might increase students' motivation towards the issue under discussion presented by concept cartoons. The proposed features can be summarised as follows;

1- Alternative to poster format, concept cartoons might be designed as in the form of worksheet.

2- Characters need to be named.

3- In case of limited drawing ability, concept cartoons might be prepared by using ready-made cartoons or only the pictures of the characters instead of drawing the cartoon context.

4- As an alternative to discussion format, cartoon characters might be thinking in silence.

Which of these suggested features make concept cartoons more effective in teaching science? This is the question motivating the present study. In other words, the present study aims to investigate the relationship between the features (i.e. listed above) of a concept cartoon as a teaching aid and its effectiveness in science classess. The term effectiveness was taken to mean producing the same/similar results with the ordinary form of concept cartoons in some cases whereas it meant producing better results in the others. Details will be given where clarification is necessary.

Research questions

In the present study, answers to the following research questions are sought;

1- Can worksheet form of concept cartoons be an alternative to poster format? In what ways it is effective in teaching science?

2- How useful is the concept cartoon characters to have a name?

3- Does drawing pictures of characters only without drawing a context for discussion affect students' way of responding?

4- Does using thinking bubbles rather than speech bubbles in concept cartoon affect the way students respond to the concept cartoon?

Methodology

Research which was conducted in Turkish primary science classes were designed to investigate the relationship between the features proposed and its usability in teaching without affecting students' response pattern. So as to investigate the research questions, both a pre-post test experimental research design and case study approach were benefited. The experimental design was used when the reseach questions required testing effectiveness in terms of instruction whereas the case study approach was used when reaserch question did not involve teaching. In other words, research questions required different methodological approach. Thus, details of the research methodology including the nature of instruction was presented in the results and discussion section

At the outset of the study a set of concept cartoons was created. Each set involved different forms of concept cartoons. The worksheets were designed by making the necessary alterations in line with the research questions to be investigated. The concept cartoons were used by the researcher while the classroom teacher was simply an observer on occasions where the research involves teaching. Different science classesses from the same primary school were involved in the study. These were 4^{th} and 5^{th} (aged 10-12) grade classes. According to the results of schools' assessment aimed at forming the classes at the beginning of the school term, students were mixed ability and have similar ability profile in terms of the school achievement test. Yet, in order to find out whether this was the case, pre test results were used to test the similarity of classess.

The main data sources were written feedback collected from the learners and field notes concerning classroom observations and video recordings of the instruction. Students' written responses to pre-post test questions and to worksheets formed the written feedback data of the

study. Researchers' field notes and video recordings of the teaching were used in decribing how the instruction carried out and how students responded to concept cartoon approach.

For each research question, at least two experiments or case studies were conducted. It was thought that this repeatedly use of case studies would be hepful in data triangulation (Huck & Cormier, 1996; LeCompte & Goetz, 1982; Silverman, 1993). Additionally, investigator triangulation was also benefitted during the data analysis of worksheets by carrying out the reliability of coding procedures (i.e. inter-coder reliability; Huck and Cormier, 1996) since students' written responses were independently coded by a second coder. An overall agreement (92%) was reached with a minimum of 88% and with a maximum of 100%. Students' open-ended responses to the questions were analysed by ideographic ways (Driver & Erickson, 1983; Kabapınar, 2003) where responses were analysed in their own terms rather than categorising them into pre-determined sets of categories. Thus, the categories were developed throughout the data analysis. So as to find out whether students in control and experimental groups were equal in terms of their understanding of the teaching concepts, Kruskal-Wallis test was used. Wilcoxon Sign testwas used to compare students' responses prior to and at the completion of the instruction.

Results and Discussion

In the following section, the methodological approach adopted and the findings obtained are presented together to explore each research question.

Effectiveness of concept cartoon teaching via worksheets

Examining the literature on concept cartoons, it becomes clear that concept cartoons are designed in poster format. As an alternative to posters, the idea of concept cartoon can also be benefitted in preparing worksheets. An example of a poster concerning the change in mass of an ice cube on melting and miniature form of it as a worksheet are given in figure 1.

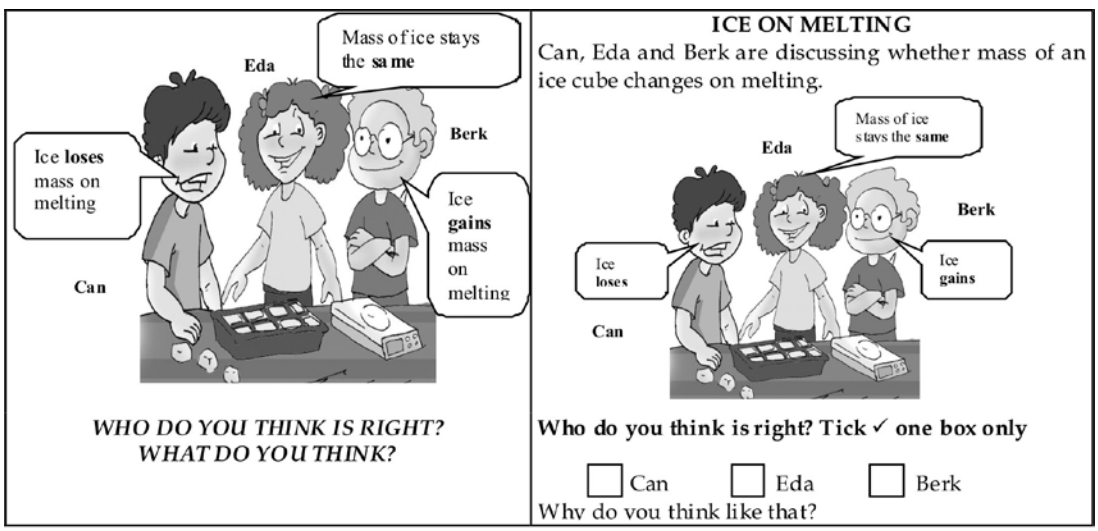

Figure 1. The concept cartoon on change in mass of an ice cube during melting (poster and worksheet)

Concept cartoons as in the form of worksheets might be as effective as, if not more than, posters in remedying students' misconceptions and helping them to understand scientific ideas via worksheets which provide a teacher with a range of alternative ways of benefiting the concept cartoon approach. For example, worksheets help organising pair or small group activities or uncovering students' individual ideas and recording them for future reference. It also provides opportunities for students to think by themselves before hearing the ideas of their classmates.

The question is whether these theoretically spoken advantages of worksheet concept cartoons exist in practice. Thus, this study aims to find out answers to questions; "Can worksheet form of concept cartoons be an alternative to poster format?" and "In what ways it is effective in teaching science?" The term effectiveness could be interpreted variously depending on the research questions answered. Here, effectiveness in teaching science was taken to mean remedying students' misconceptions.

So as to investigate in what ways a concept cartoon as in the form of worksheet were effective, 2 sets of concept cartoons were developed as in both poster and worksheet format. They focused on mass change on melting (Figure 1) and non-living nature of atoms. In the first concept cartoon, characters are discussing whether the mass of an ice cube will decrease, increase or not change on melting while they are discussing whether atoms are living or non-living in nature in the second concept cartoon. Two classes of 11-12 year olds were selected. In one of these classes, teaching was based on the concept cartoon worksheet whereas in the other it was carried out over the poster.

The teaching approach described by Keogh and Naylor (1999, p. 433) was used in teaching via posters. This teaching involved a brief introduction to the concept cartoon activity, an invitation to the learners to reflect on the concept cartoons and to discuss what they think and why. Then, they were asked to offer a practical investigation to find out which idea was correct. The investigation suggested by the class was carried out as a whole class activity where a group of students did the experiment as a demonstration. Students shared their observations and interpreted their findings. This practical investigation followed by teachers' interventions to challenge, follow up and develop students' ideas towards the scientifically acceptable viewpoints. Exactly the same teaching was used in worksheet concept cartoons except that students completed the worksheets individually at the outset of teaching and that no posters were displayed for a visual reference.

Two experiments were conducted for the melting concept. In the first experiment one of the classes received teaching via poster concept cartoon whereas worksheet form of concept cartoon was benefited in the second class. Having students responded to concept cartoons a group of students weigh a piece of ice and reweigh after it melts completely. The results are presented in table 1.

Table 1.

The Effectiveness of the Two Concept Cartoon Teaching Approaches on the Mass Change of an Ice Cube on Melting

On melting mass of an ice cube	Teaching with Poster Class 1		Teaching with Worksheet Class 2	
	Pre test	Post test	Pre test	Post test
increases	23	2	24	2
decreases	5	1	5	-
does not change	10	35	11	38
Students total	38	38	40	40

Table 1 illustrates that majority of students in both classes thought that mass of an ice cube increases during melting. In other words, the two classes were similar in nature prior to teaching. Kruskal-Wallis test results indicated no significant difference between the two groups of students regarding their answers to the pre-test. This similarity continued to exist at the completion of both teaching processes. According to the results of the Wilcoxon-Sign test which carried out separately for each group of students in order to compare ideas offered prior to and at completion of the teaching interventions, the difference was significant at the 1 per cent level[**]. Therefore it is possible to say that teaching via worksheets produced similar sorts of results on students' learning as poster based teaching approach did.

[**] Null hypothesis: 'There is no difference between ideas used prior to and at completion of teaching; rejected at 1% level

The same classes were also subjects of the second experiment. However, they were matched just the opposite. To eliminate random errors due to group properties, class 1 received worksheet based teaching approach. In this experiment, the concept cartoon was about the nature of atoms as living or non-living. Here again, it was adopted the general framework of teaching described earlier except the practical investigation part since it was not possible to carry out a practical investigation for finding out if an atom alive. Instead, students were presented the features necessary for being alive and then they were asked to decide whether an atom consists of all the features of living things. The results of this experiment are presented in table 2.

Table 2

The Effectiveness of the Two Cartoon Teaching Approaches on Non-living Nature of Atoms

Atoms	Teaching with poster Class 2		Teaching with Worksheet Class 1	
	Pre test	Post test	Pre test	Post test
are living in Nature	11	2	13	3
are non-living in Nature	2	29	-	33
alive in living things	27	9	25	3
Total number of students	40	40	38	38

A similar portrait comes out of table 2. The effect of the worksheet based teaching approach seems to be similar to that of the poster counterpart as no significant difference between the two groups of students was detected in Kruskal-Wallis test results. Majority of students in both groups thought that atoms that make up living things are living in nature prior to teaching. Distribution of students into the concept cartoon ideas was also similar in post testing. After the instruction, majority of students in both groups started to think that atoms are not alive. In fact, the number of students who started to use the scientific idea after the teaching seems to be more in worksheet-based teaching group (n= 33) as compaired to poster-based teaching group (n= 27). Yet in statistical terms, this result is not enough to make a claim that worksheet-based teaching is better than poster-based teaching. But it is well enough to make a claim that concept cartoons designed, as worksheets can be as effective as their poster counterparts in remedying students' misconceptions. During the classroom reflection activity, some of the students came nearer to the blacboard on which the poster was displayed. Upon probing the reason behind, they said that they can see the pictures, but have difficulty in reading due to their classmates' heads. Such readability problem was not experienced within worksheet-based teaching.

Effectiveness of naming the concept cartoon characters

Literature on concept cartoons indicated that naming the characters is not a condition to be met. However, naming the characters will possibly minimize classroom management problems when students responding to the question of "what do you think?" or "who do you think is right?". Students can express their ideas by simply telling the name of the character. Two classess were chosen to articulate the effectiveness of naming the concept cartoon characters. The term effectiveness is used to mean both usefulness in diminishing classroom management problems and producing similar sort of results (i.e. not causing a change in students' response pattern) with those whose characters are not named. A poster about mass of sugar on dissolving was designed where cartoon characters did not have names. The poster was similar to the one in Figure 2. Then students in a class of 5th grade were encouraged to reflect on concept cartoon activity in a whole class discussion where they had to explain what they think about it and why. The same poster was used exactly in the same way in another 5th grade science class, this time characters appearing on the poster were named accordingly.

Figure 2. Poster on mass of sugar on dissolving

The classroom observations indicated that when characters were not named, responding to the question of "what do you think?" became problematic during the classroom reflection activity. Students had to state the position of the character. For instance, they said "I agree with the girl on the left". However, they pointed to the right side. On the contrary, the classroom management was much easier with concept cartoon on which the characters had names. These students could express their ideas by simply telling the name of the character with which they agree.

The remaining case studies were conducted so as to find out whether a similar classroom management problem still existed when worksheets were used. Two worksheets were designed. The alternative ideas, including the scientific one, were the same in both worksheets, albeit worded differently. The type and position of the characters were also different so as to minimize the possibility of algorithmic responses (i.e. responding without reading). Worksheets used were given in figure 3.

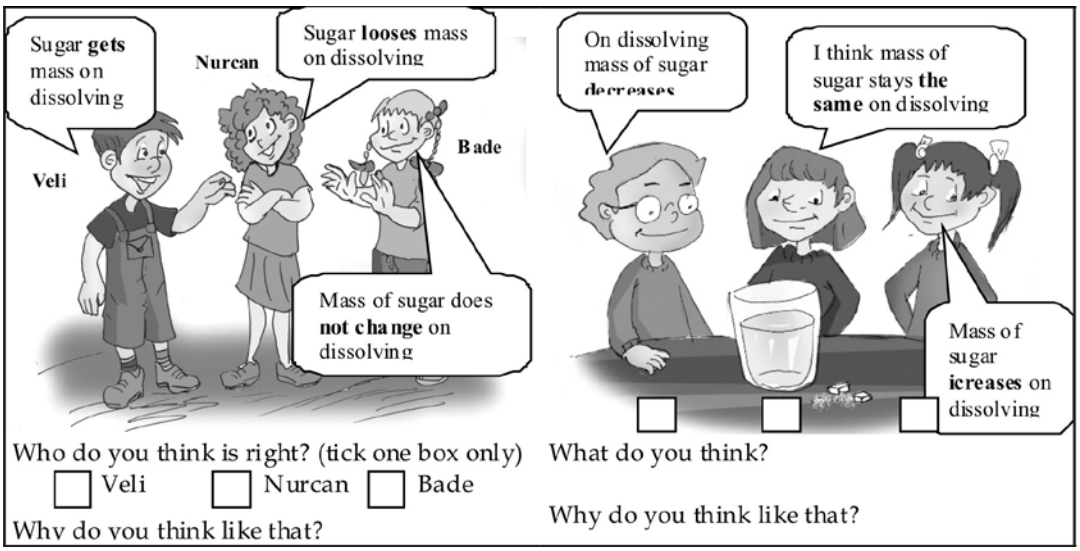

Figure 3. Worksheets about change of mass of sugar on dissolving

The case study was carried out with 4th grade science classes. Both classes responded to the question when sugar dissolves in water will its mass changes. It was found that most of the students in both classes thought that sugar looses mass on dissolving. In other words, they were similar in their responding. This similarity was supported by the Kruskal-Wallis test results. A week later, one of the classes received worksheet with characters having names. The other responded to worksheet on which characters did not have names. Students' responses are presented in Table 3.

Table 3

Students' Responses to Worksheets on Mass of Dissolved Substance

On dissolving mass of sugar crystalls	Worksheet 1 "naming" Class 1	Worksheet 2 "no naming" Class 2
decreases	30	31
stays the same	2	3
increases	-	-
Students total	32	34

According to Table 3, both classes were similar in nature as majority of students in both groups predicted that sugar looses mass on dissolving. The Kruskal-Wallis test results indicated no significant difference between the two groups of students regarding their answers.

So as to find out whether naming of cartoon characters affect students' responses two worksheets on effects of heating on volume/mass of metal ball were prepared. These were distributed to a 4th grade science class. Ideas presented in callouts were the same in both worksheets, yet wording, names and placements of ideas were different. One of the worksheets had character names. At the outset, students (n= 40) completed the first worksheet with names on it individually. This was followed by collection of the worksheets and encouragement of students to complete the second worksheet. The results of analysis of students' responses to both worksheets are presented in table 4.

Table 4

Students' Responses to Worksheets on Effects of Heating on Volume/Mass of Metal Ball

On heating, metal's	Worksheet 1 "no naming"	Worksheet 2 "naming"
volume increases, mass does not change	22	23
both volume and mass increase	12	12
volume increases, mass decreases	6	5
Students total	40	40

Table 4 indicates that students responded to both worksheets in the same way regardless of the characters having names. Individual response pathways acknowledged this similarity which was also supported by the Wilcoxon-Sign test result. Classroom observations indicated that nearly all students explain their ideas by stating the names of the characters appear on the second worksheet. Thus, it can be concluded that the characters to have a name do not cause change in students' response pattern while it does minimize classroom management problems during whole class reflection activity.

Effects of cartoon context on the way of responding

In case of limited drawing skills, concept cartoons might be prepared by using ready-made cartoons or only the pictures of the characters without a drawing regarding the phenomenon under discussion. In order to suggest this type of design for concept cartoons, its effectiveness needs to be investigated. For this reason, two concept cartoons were designed. One of them was designed as suggested by Keogh et al. (1998) whereas the other had pictures of cartoon characters only. Ideas presented in callouts were the same, yet wording, names and placements of ideas were different.

A class of 10-11 year olds (n= 43) was invited to respond individually to both worksheets concerning mass of a water molecule in turn with the picture had a place to go first. Second study was carried out with a class of 11-12 year olds (n= 19). They were asked to respond to the same worksheets but the order of worksheets was exactly the opposite. The results of analysis are presented in table 5.

Table 5

Students' Responses to Worksheets on Mass of Water Molecule

	"Pictures" first Class 1		"Cartoon" first Class 2	
Mass of water molecule is	Pictures	Cartoon	Cartoon	Pictures
more when water is solid	16	16	6	6
more when water is liquid	2	2	1	2
more when water is gas	13	13	-	-
the same in all states	10	10	12	11
Total number of students	43	43	19	19

According to Table 5, students in both classes responded to both worksheets in similar manner. In other words, drawing the pictures of the characters without a cartoon context did not affect the way students respond to the concept cartoon. Individual response pathways and Wilcoxon-Sign test results also acknowledged this similarity. Classroom field notes indicated no difference in students' motivation. Having said that upon probing their preferences, some students showed tendency towards worksheet with cartoon contexts. There is no doubt that drawing cartoon context is more motivating than drawing only pictures of the cartoon characters. Yet, on occasions of limited sources or drawing ability concept cartoons might be prepared to have pictures of the characters without cartoon context since they appear to be as effective as the one involved drawings of the cartoon context.

So as to find out whether the nature of characters affects students' ideas, an additional case study was conducted. Concept cartoon designed was about mass change of iron nails during rusting. Two worksheets were designed. In the first worksheet made-up cartoon characters were used whilst the second consisted of animal figures. Ideas presented in callouts were the same however worded rather differently. Besides, the placement of the ideas was different in order not to encourage students to respond automatically without thinking. The second worksheet is presented in figure 4.

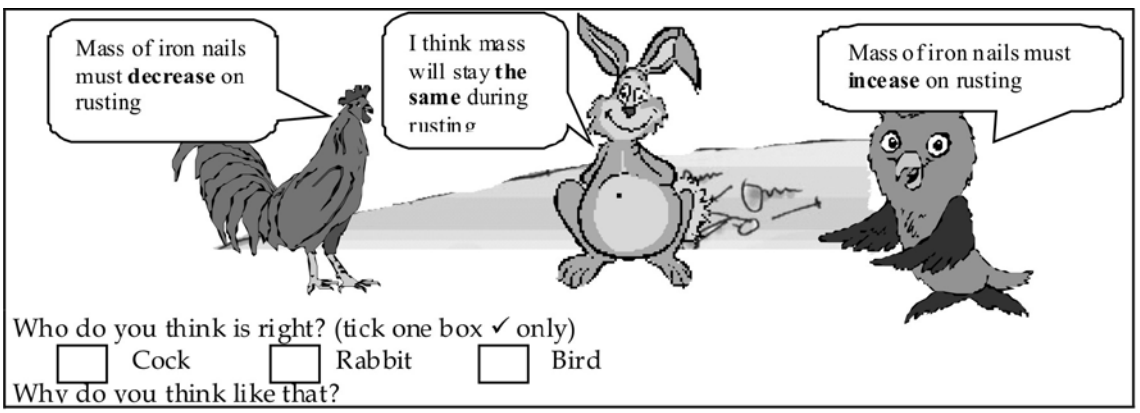

Figure 4. The concept cartoon with animal figures on change in mass of nails on rusting

A class of 11-12 year olds (n= 33) was invited to complete the worksheets in turn (i.e. worksheet 2 was distributed after worksheet 1 was collected) in the order shown in table 5. Individual responses to worksheets were analysed and the results are given in table 6.

Table 6

Students' Responses to Worksheets on Mass Change During Rusting

On rusting mass of iron nails	Worksheet 1 "human"	Worksheet 2 "animal"
decreases	13	14
increases	3	3
do not change	17	16
Total number of students	33	33

Table 6 shows that students responded to both worksheets in similar manner regardless of the nature of characters. Similar results were also obtained from the second case study where two worksheets were designed. In the first worksheet cartoon film characters (Tom, Jerry and Twigy) were used while made up cartoon characters used in the second. A class of 10-11 year olds (n= 39) were encouraged to respond to worksheets that were about effects of heating on volume and mass of a metal ball. The order of worksheets is shown in table 7.

Table 7

Students' Responses to Worksheets on Effects of Heating on Volume/Mass of Metal Ball

On heating, metal ball's	Worksheet 1 "film"	Worksheet 2 "human"
volume increases, mass does not change	21	23
both volume and mass increase	12	11
volume increases, mass decreases	6	5
Total number of students	39	39

Here again students chose the same idea regardless of the type of characters used in the concept cartoon. This similarity was also supported by both individual response pathways and the Wilcoxon-Sign test. Therefore, it is possible to claim that the type of cartoon characters does not affect the nature of students' responding. Clasroom observations showed that students were asking which idea was correct by saying the names of animal or film characters. The tendency towards cartoon and animal characters were sustained upon probing students' preferences concerning types of cartoon characters. This was interpreted as animal and film characters are highly motivating and easily remembered as compaired to made-up cartoon characters.

Effects of the types of cartoon activity on the way of responding

Keogh, Naylor and Wilson (1998) emphasise that cartoon characters need to be drawn in dialogue form (i.e. debating). An alternative to this, characters might be thinking about the phenomenon. Or alternatively, some characters might be discussing whereas some pondering on the issue. Thus, speaking and thinking callouts can be used together. Using thinking callouts might however decrease creadibility or status of some ideas and affect students' responces. For instance, students might interpret thinking callouts as representing unsure (not right) ideas as compaired to speaking callouts.

In order to find out whether the type of cartoon activity affects students' way of responding, three case studies were conducted. Two concept cartoons were designed as in the form of worksheets one of which had speaking callouts whereas the other had thinking callouts. Ideas presented in callouts were exactly the same in both worksheets. However, the wording, placement and names of the characters were different.

In case study 1, a class of 10-11 year olds (n= 44) was invited to respond individually to both worksheets in turn with speaking callouts had a place to go first. In case study 2, a class of 13-14 year olds (n= 36) responded to the same worksheets but the order of the worksheets was just opposite. The results of analysis of students' responses to both worksheets are presented in table 8.

Table 8

Students' Responses to Worksheets on Mass of Water Molecule

	Case study 1 "speaking" first Class 1 No. 44		Case study 2 "thinking" first Class 2 No. 36	
Mass of water molecule is	Speaking	thinking	thinking	speaking
more when water is solid	18	19	17	17
more when water is liquid	3	2	1	1
more when water is gas	13	13	-	-
the same in all states	10	10	18	18
Total number of students	44	44	36	36

Table 8 indicates that students in both classes responded to both worksheets in similar manner regardless of the type of the callouts used. This similarity was also supported by both individual response pathways and Wilcoxon-Sign test results.

So as to find out whether using both speaking and thinking callouts in the same concept cartoon was influential in shaping students' responses, a class of 10-11 year olds (n= 40) asked to reflect upon concept cartoons on non-living nature of atoms. One of the worksheets included both thinking and speaking callouts together while the second involved speaking callouts only. The worksheet with mixed callouts was distributed first. The results of students' responses to worksheets are presented in table 9.

Table 9

Students' Responses to Worksheets on Non-living Nature of Atoms

Atoms	Worksheet 1 "mixed"	Worksheet 2 "speaking"
are living in nature	11	11
are non-living in nature	2	2
found in living things are living and vice versa	27	27
Students total	40	40

According to Table 9 students' responses to worksheets were very similar regardless of the type of callouts used. This similarity was supported by Wilcoxon-Sign test results. Types of callouts seem not to be influential over the way of students responding. Students appear not to interpret thinking callouts as representing unsure ideas as compaired to speaking callouts.

Conclusions and Recommendations

Faced with new teaching approach, the first thing an educator should do is to investigate the effectiveness of it. Concept cartoon approach has gone through a similar evaluation period. Some of the educators evaluated its effectiveness based on classroom observations (Keogh, Naylor & Wilson, 1998; Morris, 2007). Some evaluated its effectiveness through the eyes of students, teachers and student teachers (Keogh & Naylor, 1999; Keogh & Naylor, 2000b). Some on the other hand, evaluated its effectiveness by investigating changes/progression in students' ideas over the course of instruction (Kabapınar, 2005; Oluk & Özalp, 2007; Stephenson & Warwick, 2002).

Effectiveness is also a key term for understanding the present study. Yet, this study approached the term from a rather different perspective. The issue was not finding out the effectiveness of concept cartoons but it was finding out how to design concept cartoons to increase their effectiveness. For this reason, alternative ways in designing concept cartoon were proposed, their effectiveness was investigated and compaired with the conventional one.

There are three broad implications of this study. The first of these is the increase in effectiveness of concept cartoons when cartoon characters to have names. Naming characters diminished potential classroom management problems during whole class reflection activity. The second implication is the increase in effectiveness of concept cartoons when they are in the form of worksheets. As compaired to posters, worksheets seem to provide students to control their pace of reading and comprehension of the concept cartoon context. The last implication is the enrichment of the usability of concept cartoons when they are designed to have characters only. This is because such simplistic design, which appears to be as effective as the conventional one, might increase its usage by those who have limited drawing skills.

As previously stated the existing research provided evidence that teaching via concept cartoons is effective in finding out students' misconceptions (Naylor, Keogh, de Boo & Feasey, 2001; Pelaez, Hoover & Treagust, 2004) and promoting students' understanding (Keogh & Naylor, 1999; Stephenson & Warwick, 2002). Investigating the benefits of teaching via concept cartoons in promoting understanding was not primarily focus of the present study. Yet, it produced strong evidence that teaching via concept cartoons was effective in uncovering the reasoning behind students' misconceptions and in remedying them. Concept cartoons seem to encourage a natural relationship between finding out the children's ideas, investigating and developing scientific ideas. But there are some simple ways to make them more effective as the present study indicated by enlarging the ways of their usage.

In the present study, concept cartoons were designed fully to reflect the features to be investigated. In case of limited drawing ability students might be asked to design the concept cartoons for themselves. Effectiveness of such designs and their potential benefits over students' learning might be subject to future studies. On examination of the related literature, it becomes clear that concept cartoons are embedded in different teaching models depending on the learning strategy adopted. A favourable model in using a concept cartoon is to adop cognitive conflict strategy. The teaching approach suggested by concept cartoons' creators (Keogh & Naylor, 1999) and 5E model (Morris et al., 2007) are the ones used favourably. Similarly, a teaching sequence that follows cognitive conflict and its resolution through discussion and collaboration is used (Dabell, 2008). Accepting that learning should be viewed as a social process, concept cartoons act as a tool for argumentation. Therefore, in designing teaching scheme collaboration and discussion where teacher acts to scaffold understanding can be emphasized. Studies need to be designed to investigate effectiveness of such teaching approaches over students learning.

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