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Effect of Using Culturally Responsive and Differentiated Concept Cartoons on Students' Academic Success and Attitude in Science Teaching*

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Abstract

Effect of using of culturally responsive and differentiated concept cartoons (CRDCCs) in science teaching on students' academic achievement in 'Our World, Moon and Our Source of Life: Sun' unit and attitudes toward astronomy were inspected in this study. The study has been conducted in quasi-experimental designs. Study group of the research includes 80 voluntary 6th graders selected from two different schools in Akçakale province. '6th Class Our World, Moon and Our Source of Life: Sun Achievement Test' and 'Astronomy Attitude Scale' were utilized to determine academic achievement and attitude levels of students, respectively. CRDCCs supported lectures have lasted for 4 weeks. To collect data, only attitude scale at the beginning and both attitude and achievement tests were applied at the end of the study. To observe whether treatment and control group scores differ from each other, Independent Samples T Test and Covariance Analysis were applied respectively. In addition, data was analyzed according to various variables to be able to draw a profile of the study group. Findings revealed that group scores are differentiated in treatment group's favor. As a result, CRDCCs are effective instructional tools to increase academic achievement in regarding unit and develop positive attitudes toward astronomy.

Keywords

Multicultural Education
Concept Cartoons
Astronomy
Academic Achievement
Attitude

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Fen Öğretiminde Kültüre Duyarlı ve Farklılaştırılmış Kavram Karikatüleri Kullanımının Öğrencilerin Akademik Başarı ve Tutumlarına Etkisi

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Öz

Bu çalışmada fen öğretiminde kültüre duyarlı ve farklılaştırılmış kavram karikatürleri kullanımının öğrencilerin 'Dünyamız, Ay ve Yaşam Kaynağımız Güneş' ünitesindeki akademik başarılarına ve astronomiye yönelik tutumlarına olan etkisi araştırılmıştır. Araştırma yarı deneysel desenler çerçevesinde, akademik başarıya olan etki son test eşleştirilmiş kontrol gruplu desende, astronomiye ilişkin tutumlara etki ise öntest-sontest eşleştirilmiş kontrol gruplu desende gerçekleştirilmiştir. Araştırmanın çalışma grubunu Akçakaledeki farklı iki okuldan seçilen 80 gönüllü 6. Sınıf öğrencileri oluşturmaktadır. Öğrencilerin akademik başarıları '6. Sınıf Dünyamız, Ay ve Yaşam Kaynağımız Güneş Ünitesi Başarı Testi' ile astronomiye yönelik tutumları ise 'Astronomi Tutum Ölçeği' kullanılarak belirlenmiştir. Geliştirilen kavram karikatürleri ile işlenen dersler 4 hafta sürmüştür. Araştırma verileri araştırmanın başlangıcında tutum ölçeği, sonunda ise hem başarı testi hem tutum ölçeği uygulanarak toplanmıştır. Gruplar arasında akademik başarının anlamlı farklılaşıp farklılaşmadığının ortaya çıkarılması için bağımsız örneklemler için T testi, grup tutumlarına ilişkin farklılaşmanın incelenmesi için kovaryans analizi gerçekleştirilmiştir. Ayrıca çalışma grubunun genel bir profilinin çizilebilmesi açısından elde edilen puanlar çeşitli değişkenler çerçevesinde – *Cinsiyet, Anne Eğitim Durumu ve Baba Eğitim Durumu* incelenmiştir. Elde edilen bulgulara göre deney ve kontrol grup puanlarının deney grubu lehine anlamlı derecede farklılaştığı gözlenmiştir. Buna göre çokkültürlü eğitim anlayışı çerçevesinde hazırlanmış kavram karikatürlerinin bahsedilen üniteye ilişkin öğrencilerin akademik başarılarını artırmada ve astronomiye yönelik olumlu tutum geliştirebilmelerinde etkili bir öğretim aracı olduğu sonucuna ulaşılmıştır. Sonuç olarak; akademik kazanımlar ve akademik başarı değişkenleri için; akran ilişkileri, kampüs etkinliklerine katılım ve algılanan İngilizce yeterlik düzeyi ortak anlamlı değişkenler olarak ortaya çıkmaktadır. Kampüs etkinliklerine katılım ise tüm sonuç değişkenleri için anlamlı bir yordayıcıdır.

Anahtar Kelimeler
Çokkültürlü eğitim
Kavram karikatürleri
Astronomi
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INTRODUCTION

In today's world many societies have unique mosaic structure comprising various cultural, religious and ethnic elements. The Republic of Turkey is a relatively young state has been founded upon some remnants of Ottoman Empire lands which was also contains different national and cultural minorities. Being heir of an empire makes Turkey a multicultural state and its youth leads to the fact that adequate attention is not still paid to educational efforts as much as prosperous countries do. Since population is getting diversified day by day in Turkey, one of the most prioritized topics in national education is integration of minorities into the society. Although more attention is paid to minorities after mass civil migration from Syria, there are still other people who should be at focus of interest.

Akçakale is a Turkish border town between Turkey and Syria where almost all citizens are Arab originated. Although they identify themselves as Arab, in fact, they grow up in a culture which is a mix of Turkish and dominantly Arab, so none of these cultures can be fully or meaningfully embraced by these people. Therefore, this situation primarily brings about cultural clashes more than a harmony in any piece of life and this study focuses educational side of the issue.

People in Akçakale have their own, mostly Arabic, traditional lifestyle. Hence children grow up in an environment where they communicate via a special language which is also mixture of Turkish and Arabic like their cultures. As some children even encounter Turkish for the first time at schools where the official medium of instruction is Turkish, cultural distinction between home and school begins to appear. According to García (2005) this difference is important to meet effectively educational needs of bilingual students and provide a dynamic understanding about variables affecting student learning. When The fact that students in Akçakale have nearly the lowest academic success in national high-stakes tests is taken into the consideration, it can be said that some educational interventions are inevitable to ameliorate academic success of the students.

In this context, this study aimed to examine the effect of using a special kind of concept cartoons such as culturally responsive and differentiated concept cartoons (CRDCCs) on academic achievement and attitude towards astronomy in a selected unit. Culturally responsive and differentiated concept cartoons are newly introduced tools which arise from incorporation of multiculturalism and constructivism in education.

Literature Review

The relationship of multiculturalism with education stems from the fact that each child is an individual, awareness of individual differences and respect for different cultures. Variety in ethnic structure of a society creates gap in integration of minorities into society (Erbas, 2019) and to fill it, notion of multicultural education is used by researchers. Multicultural education is defined as ideas and approaches reflecting educational side of multiculturalism and affirming multicultural policies in education (Başarır, Sarı & Çetin, 2014; Yazıcı, Başol & Toprak, 2009). According to Au (2009), multicultural education is basically to help students by considering their ethnic diversity as an opportunity for their education, to bring them in knowledge, skills, and behaviors to carry out diverse educational activities and to reshape schools accordingly.

Banks and Banks (1995) mention four approaches – *contributions, additive, transformative and social action* depending on their degree of intervention to curriculum. The contributions approach predicts the minimum level of changes or interventions in the curriculum, whereas the social action approach predicts the most radical changes. In contributions approach, accordingly, various societal and cultural elements like celebrity characters, special days, holidays, and events improve teaching by contributing the curriculum. Before additive approach, Banks and Banks (1993) mentioned infusion approach that is highly similar to additive approach and foresees making the curriculum multiculturally fit by adding material to whole curriculum or extending scope of material as much as possible. similarly, additive approach recovers teaching via adding content, materials, ideas, themes, and perspectives without changing its fundamental schema. it is basic to not change dramatically main structure of curriculum in contributions, infusion, and additive approaches. Furthermore, these are referred as instrumental approaches because they do not intend to radical changes in curriculum. in contrast, alterations in curriculum and teaching implications are foreseen in transformative approach to encourage student empowerment and to increase readiness to social action. at the end, in social action approach which is based on transformation, teachers and students are expected to be more participatory manner to create a social action (Johnson, 2002).

In Akçakale, as mentioned before, there is a gap between mainstream and home cultures. To illustrate this, various use of words and sayings in different locations of Turkey where almost all citizens Arab originated are given in Table 1.

Table 1. Several Words and Sayings in Different Forms and Locations

English	Turkish (Mainstream Language)	Modern Standard Arabic	Local Language (Kozan)	Local Language (Akçakale)
Sun	Güneş	Şems	Şems	Şems
Moon	Ay	Kamer	Emer	Gumar
Sky	Gökyüzü	Semâ	Semâ	Essimi
Star	Yıldız	Necm	Necme	Necm
Mountain	Dağ	Cebel	Cebel	Cibel(e)
Hill	Tepe	Kımme	Telle	Teppı
Night	Gece	Leyl	Leyl	Lel
Morning	Gündüz	Nehâr	Nehâr	Nıhâr
Noon	Öğle	Zuhr	Duhr	Zuhur/Duhur
Evening	Akşam	Işâ’	Işâ	Mıgrıb
Morning	Sabah	Sabâh	Sabh	Subıh
Tomorrow	Yarın	Ğaden	Bukra	Beçir
Yesterday	Dün	Emr(bârih)	Bârih	Elbârih
Week	Hafta	Usbû’	Usbû’	Haftı
Past	Geçmiş	Mazî	Mazî	Feyit
Future	Gelecek	Kâdim	Câyi	Diyiciy
Before	Önce	Kabl	Ebl	Evvalfel
After	Sonra	Ba’d	Ba’deyn*	Ugub
How old are you?	Kaç yaşındasınız?	Kem umruk?	Kıddâş umruk	İşked umrak?
See you later	Görüşmek üzere	İle’l-likâ	Neltekı	İnsufbadni
What time is it?	Saat kaç?	Kemi’s-sâa?	Kıddâş sâah?	Essae işged?

Table 1 shows that large differences in spoken language can be seen even in close quarters. According to Diaz and Klinger (1991) language plays an important role in cognitive development. Children whom their native language is not the same with school language are disadvantageous in terms of cognitive maturing. They have difficulty to make shifts between home and school concepts which directly affects academic success of the students. This idea is corroborated by García (2005) by stating that if students' native culture/language is rejected or omitted in the class, their cognitive growth and related academic achievement will be limited. It is the fact, which is easily attainable from national resources that, on the other hand, Akçakale reveals constant academic insufficiency in national exams.

Astronomy education in Turkey starts from the 3rd grade and, in curriculum, astronomy related subjects last until 8th grade with an increasing content. Science education curriculum has been updated lastly in 2013 and 2018 by Turkish Ministry of National Education. One of the changes appearing with this renewal is that astronomy subjects are placed in first unit of the science classes. Previously, astronomy related topics was taught in the final units. Although no scientific study was encountered in literature articulating what factors that push curriculum makers to do this change are, it will be reasonable to assume that this update is due to decreasing motivation and academic achievement toward astronomy caused by relaxation coming with end of the academic year. As stated by Saraç (2017) wide spectrum of astronomy-related studies for example identification of understanding level and misconceptions, conceptual change processes, mental models about earth and universe, also student attitudes and views towards astronomy, academic achievement in science education were performed.

Concept cartoons which are products of integration of constructivist understanding into science education, can be used as motivation enhancer leading minimization of classroom problems (Kabapınar, 2005), and eventually, increase academic achievement (Altunkara, 2013; Atasoy & Ergin, 2017; Atasoy, Tekbıyık, & Gülay, 2013; Balım, İnel, & Evrekli, 2008; Balım et al., 2015; Chen, Ku, & Ho, 2009; Çelik & Gündoğdu, 2016; Dereli, 2008; Durmaz, 2007; Durualp, 2006; Özüredi, 2009; Özyılmaz-Akamca & Hamurcu, 2009; Yılmaz, 2013). Some properties of contemporary concept cartoons are identified by Naylor and Keogh (2013).

- They include everyday situations instead of giving scientific facts directly which leads more student engagement with science without fear. Since everyday situations are geographical and cultural free, concept cartoons can be used in a wide range of countries.
- They present at least one scientific idea that brings more challenge especially for high achieving students.
- They have additional blank speech bubble which can be used as a trigger to hearten students to explore alternative ideas by implying that there may be another acceptable idea.
- Student language is used in background text. Familiarity increases usage ways of concept cartoons in the classroom.
- All ideas are equally reasonable in concept cartoons. Minimized contextual clues like facial expressions or wording statements are offered by researchers.

- Common misconceptions are included in concept cartoons. Researchers set forth that concept cartoons are effective tools in eradication of misconceptions when they are used properly.
- They consist conceivable ideas which stem from research evidence about students' ideas at different ages.

Purpose

When the extant literature is reviewed it can be said that pedagogy, curriculum, educational policies, teacher education and materials related to multicultural environment are mostly studied topics in multicultural education. Two of them, curriculum, and teacher education, intersect each other at the emphasis on inclusion of new materials to education. The lack of research presently available on more sophisticated tools warrants further research on academic achievement and attitudes of multicultural students.

The aim in this study is to inspect effect of using of culturally CRDCCs in science teaching on 6th grade students' academic achievement in 'Our World, Moon and Our Source of Life: Sun' unit and attitudes toward astronomy. This study is guided by the following research questions:

1) Does use of CRDCCs in science teaching create significant difference between groups' academic achievement scores?
2) Does use of CRDCCs in science teaching create significant difference between groups' attitute scores towards astronomy?
3) Does students' academic achievement scores differ in terms of their gender?
4) Does students' attitude scores towards astronomy differ in terms of their gender?
5) Does students' academic achievement and attitude scores towards astronomy differ in terms of their parents' educational background?

METHOD

Research Pattern

The study has been conducted in quasi-experimental designs; The Matching-Only Posttest-Only Control Group Design for academic achievement, The Matching-Only Pretest-Posttest Control Group Design for attitudes of students. Experimental designs are not easy to implicate and powerful way to attest cause-and-effect relationship among variables (Fraenkel, Wallen, & Hyun, 2011). Study groups were matched according to students' cumulative science scores in first school term and the most successful ones are invited to join the study. Büyüköztürk, Kılıç-Çakmak, Akgün, Karadeniz, and Demirel (2009) stated that even if randomization never can be replaced by matching, it is a good alternative when randomization is not available.

Study Group

The study was performed by attendance of 80 consented students, 40 students for each of treatment and control groups. The study group comprises 27 female and 53 male 6th graders from two different villages of Akçakale.

Data Collection Tools

Achievement test

The tool was developed by Karamustafaoğlu and Tutar (2016) to assess to what extent objectives of *'Our World, Moon and Our Source of Life: Sun'* unit are attained by students. The objectives for regarding unit are:

Students will be able to;

- Compare Shapes and sizes of the Earth, Sun, and Moon thanks to the model they formed.
- Explain the model represents the Earth's layered structure and compares these layers according to their specifications.
- By expressing that the moon rotates around itself and it orbits the Earth, form and present the model which represents these motions.
- Express phases of the moon and links reasons for them to orbital motion of the moon around the earth.

Pilot study was conducted in Amasya with 288 7th grade students because final students who took science course with aforementioned objectives are momentarily 7th graders in item development process. After the pilot study and statistical item analyses, the test finalized with 27 items after removal of 5 of them. KR-20 value regarding the test was calculated as .78.

Astronomy attitude scale

Türk and Kalkan (2015) developed the scale to discover 7th grade students' attitudes towards astronomy, subjects related to astronomy, the relationship between astronomy and daily life and their attitudes towards the studies conducted. Sample of the study includes 302 7th grade students from Black Sea Region of Turkey. Exploratory factor analysis was utilized to end the scale. Calculated internal consistency coefficient value for Cronbach Alpha is .91. With five sub-scales, it has 5-point Likert 27 items of which factor loadings changes between .52 and .77.

Personal information form

It was used to collect data regarding independent variables of the study which are gender, educational status of parents.

Preparation and use of CCRDs

A comprehensive literature review for student misconceptions about treatment unit was conducted to generate alternative ideas in concept cartoons. In creation stage of concept cartoons, contemporary criteria set forth by Naylor and Keogh (2013) were adopted. All texts, to put in speech bubbles, were translated from original language to indigenous form via simultaneous cooperation and interactive when needed, of 3 Turkish-Language teachers who are familiar with Akçakale environment from their childhood. CRDCCs reached the latest version after proper professional graphic manipulations. CRDCCs have been used for 4 weeks in treatment group within the framework lesson plans prepared according to 5E teaching model. Only astronomy attitude scale at the beginning, both the attitude scale and the achievement test at the end of the data collection process have been administrated.

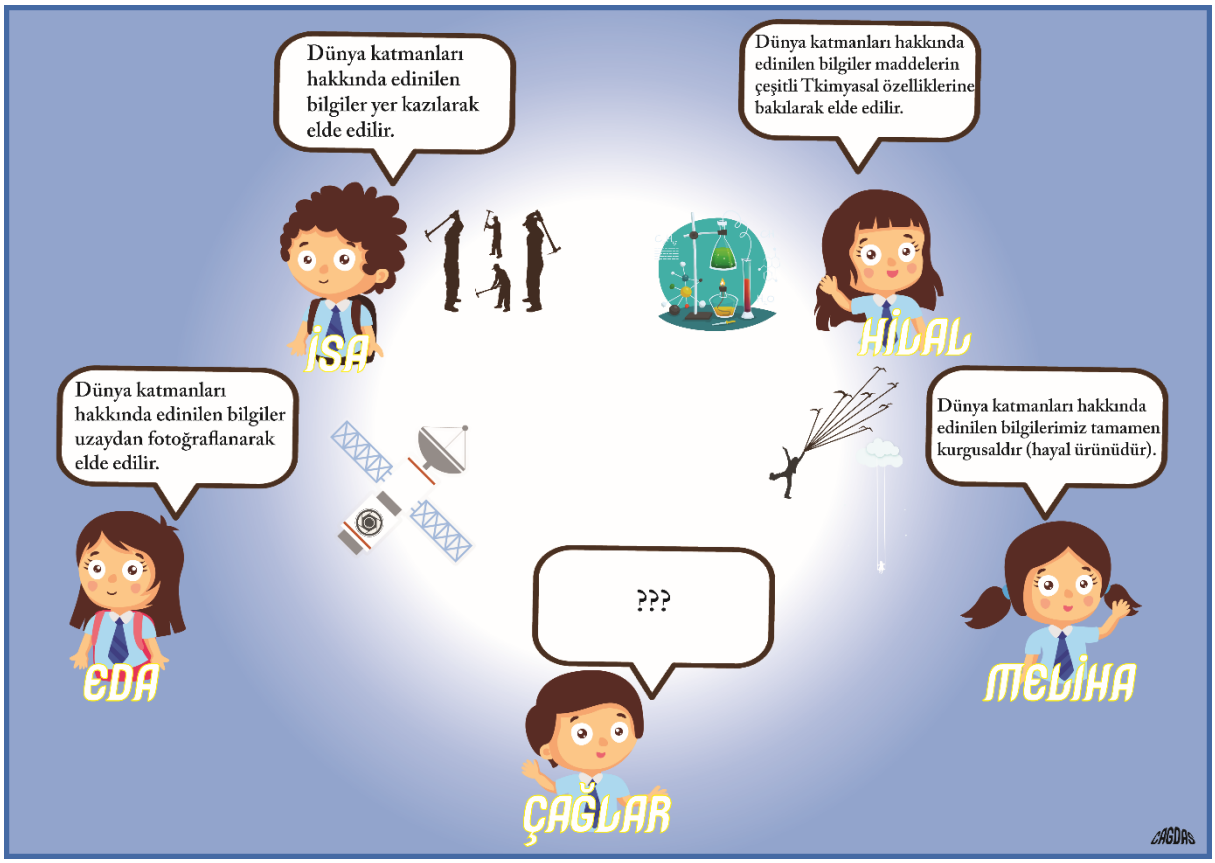

Figure 1. Turkish Concept Cartoon Sample

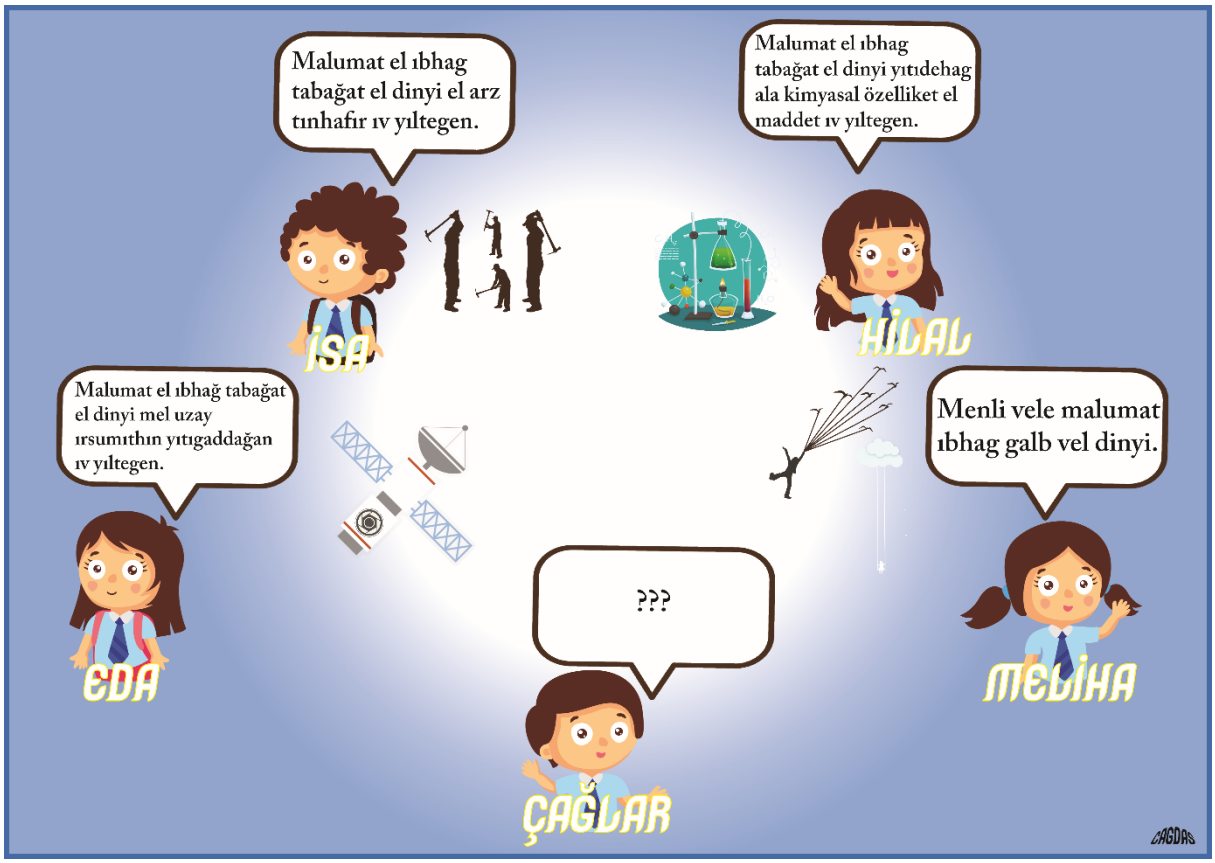

Figure 2. Arabic Concept Cartoon Sample

Data analyses

In educational research, effect of independent variable on treatment group can be investigated with pre-test post-test comparative designs. ANOVA or repeated measures ANOVA is generally used in analysis of such designs. The main aim in ANOVA is to examine effect of independent variable together with dependent variable (Creswell, Plano Clark, Gutmann & Hanson, 2003) but use of pre-test scores as covariable in ANCOVA provides researchers with more trustworthy and informative results. With this regard, independent samples T test for difference in groups' average scores on achievement test, analysis of covariance (ANCOVA) for change with time in groups' attitudes towards astronomy, and independent samples T test or one-way analysis of variance (one-way ANOVA) for data related to dependent variables were conducted.

FINDINGS

For the first question of the study, achievement test means for control and treatment groups were compared using independent samples T test.

Table 2. Independent Samples T Test Results of Groups in Terms of Academic Achievement

Group	M	SD	t	p	η^2
Control	12.52	7.79	2.087	.04	.05
Treatment	15.97	6.96			

Results indicate that the mean achievement score obtained by control group was 12.52 (M=12.52, SD=7.79), while the mean achievement score obtained by treatment group was 15.97 (M = 15.97, SD = 6.96). Difference between these two means was significant [$t(78)=2.087$, $p<.05$, $\eta^2=.05$]. As it is seen, achievement mean score for treatment group was higher and calculated effect size was small.

For the second question, ANCOVA was conducted to compare the effectiveness of treatment while controlling for pre-test scores.

Table 3. ANCOVA Results of Groups in Terms of Attitude Towards Astronomy

Variance Source	Sum of Squares	df	Mean Square	F	p	ω^2
Pre-test	6726.61	1	6726.61	94.72	.00	.02
Group	324.390	1	324.39	4.56	.03	
Error	5468.139	77	71.01			
Corrected Total	12245.95	79				

It was seen that assumptions are met after Levene's test and normality examinations. There was a significant difference [$F(1, 77)=4.57$, $p<.05$, $\omega^2=.02$]. Mean score of treatment group (M=91.07, SD=14.01) attitude towards astronomy is higher than control group's have (M=89.47, SD=10.78) according to multiple comparison Bonferroni test. Calculated omega-squared value revealed that effect size was small.

For the third question, academic achievement of students was inspected according to gender.

Table 4. Independent Samples T Test Results of Genders in Terms of Academic Achievement

Group	M	SD	t	p	η^2
Male	13.96	7.48	.475	.64	-
Female	14.81	7.78			

Independent samples T test results showed that female students are more successful than males however there is no significant difference between mean scores of them [t(78)=.47, p>.05].

For the fourth and fifth questions, one-way ANOVAs was conducted seperately to demonstrate whether student academic achievement and attitude scores differ according to their parents' educational status.

Table 5. One way ANOVA Results of Parents' Educational Status in Terms of Academic Achievement and Attitude Towards Astronomy

		Father						Mother					
		n	M	SD	F	s	p	n	M	SD	F	s	p
Academic Achievement	IL	8	14	8.65	2.39	4.75	.58	49	12.9	7.7	1.95	3.76	.12
	PS	18	11.5	7.6				15	16.7	7.54			
	MS	39	14.1	7.33				14	17	6.35			
	HS	13	19.4	5.48				-	-	-			
	UN-H	2	10.5	9.19				2	10.1	3.53			
Attitude Towards Astronomy	IL	8	90.5	9.18	.78	4.75	.54	49	88	10.89	1.99	3.76	.12
	PS	18	87.2	11.4				15	93.8	11.32			
	MS	39	89.6	12.89				14	92.2	16.89			
	HS	13	94.2	14.74				-	-	-			
	UN-H	2	99	5.65				2	104.5	12.02			

IL: Illiterate, PS: Primary School, MS: Middle School, HS: High School, UN-H: University and Higher.

Table 5 shows that there is also no significant difference among educational levels of fathers [F(4,75)=2.39, p>.05] and mothers [F(3,76)=1.95, p>.05] for academic achievement, and of fathers [F(4,75)=.78, p>.05] and mothers [F(3,76)=1.99, p>.05] for attitude towards astronomy; therefore no post hoc test was proceeded. Indication of educational status of parents with numbers, on the other hand, was found valuable to put in this study for researchers to make further predictions.

DISCUSSION, CONCLUSION & SUGGESTIONS

This paper reports effects of an educational intervention in a place where different cultures meet that is supposed to lead to academic failure and low level of positive attitude towards astronomy.

Within the frame of first research question, it is seen that the success of 6th grade students in Akçakale is increased by the inclusion of CRDCCs into lectures. The affirmative effect of the treatment on academic success can be discussed from two different aspects. Firstly, it can stem from culturally responsive nature of the study; any kind of endeavors that have been developed and conducted within the framework of multicultural understanding raise student performance in educational environments. Korn (2002), for instance, alleges that students develop common identity in an environment where their cultural needs are taken into consideration and met, which paves the way to academic flourish at the end. Ware (2006) mentions biological origin based cultural responsiveness and corroborates it by stating that African American teachers have unique and culturally specific teaching styles that increase the academic achievement of students of the same origin. According to Shibuya (2011) disclosure of high academic success provided by language support for foreign students result

in positive ethnic identity development. Secondly, it is true to say that improvement in academic status of the students is attributed to buttress of lectures with concept cartoons. In Turkey, many studies (Altunkara, 2013; Atasoy and Ergin, 2017; Atasoy et al., 2013; Balım et al., 2008, 2015; Çelik and Gündoğdu, 2016; Dereli, 2008; Durmaz, 2007; Durualp, 2006; Özüredi, 2009; Özyılmaz-Akamca and Hamurcu, 2009; Yılmaz, 2013) shared wide range of the same derivation. Statistical differentiation between control and treatment group scores reveal that concept cartoons can be utilized to promote academic success, however, use of them as a sole tool may not be sufficient, more sophistication like creating them in multicultural understanding is required to change the effect size from low to high.

In addition, use of CRDCCs in science teaching facilitates students' positive attitude development towards astronomy. Though several studies (e.g., Dereli, 2008; Kaptan & İzgi, 2014) share similar outcome, no study has been encountered in literature revealing direct relationship between use of concept cartoons and positive attitude development. At this point, we offer another kind of relational model among variables instead of comparing with other studies in literature. In this model, effects of stimuli on behavior are mediated by various transformation processes where mediators describe how external physical events take on internal psychological significance (Sarıçam & Çetinkaya, 2017). According to our explanation, academic achievement or positive attitude development may play a mediator role in escalation of each other. That is to say, at the end of the treatment process, students' academic achievement may be increased, fully or partially, by positive attitude development or vice versa. Students may feel like 'I can understand astronomy or astronomy related concepts' as long as they obtain higher scores.

Within the frame of second research question, findings were analyzed in terms of students' gender and educational status of their parents, namely the final educational degree they achieved. It is worthy to notify that this was made not only because of making comparisons but drawing an educational profile of the parents of the study group. Firstly, although there is no significant difference in academic achievement and attitude scores according to the gender, it is seen that females are more prospering. It is not merely inborn disposition bringing about this outcome, environmental or cultural conditions have also grim effects. Active participation of the women in business life is dramatically low, they spend their most of the time caring their children and daily routines. Attending school and pursuing a professional career may be perceived as a way of escaping this type of living. From this aspect, our research reinforces the idea stated by Credé & Kuncel (2008) that academic success and positive attitude are good predictors of each other. Secondly, according to educational level of the parent, no significant differences were found in academic achievement and attitude mean scores. Although a systematic pattern of change based on educational level were not obtained, attitude scores noticeably increase with graduation degree of the parents. A vast amount of attention should be paid to the proportion of higher school graduate parents at this point. The better part of mothers is illiterate, almost half of fathers are middle school graduates and a small proportion are university graduates. Families having relatively low education levels may be the reason for the lack of attitude towards astronomy. Parallelly, students whose at least one of their parents is university graduate surpass the sample's average achievement score. This is another revelation that academic success can be related with student attitude.

All in all, CRDCCs have been found to be an effective teaching tool in increasing students' academic achievement and developing positive attitudes towards the unit taught. In

addition, although gender-based differentiation is not observed in academic achievement and attitude towards astronomy, girls seem more successful and more inclined to develop positive attitudes. Educational levels of parents are also not a distinguishing variable of academic achievement and attitude. Finally, low education level stands out when the parent profile of students considered in Akçakale's village schools.

Various suggestions for further research and implications have been presented based on the findings. Though teaching materials prepared in local language were used, data could only be collected by the tools in Turkish. Developing and using valid and reliable measurement tools in the local language will provide healthier results. In addition, randomization can be made to create more powerful designed research. Awareness programs may be organized primarily for teachers working in regions where culturally diverse students are concentrated. Thanks to this way, if possible, they may be provided with in-service training about preparation and effective use of concept cartoons. Although the concept cartoons used in the study are prepared by using professional graphic design programs, it is believed that addressing more senses in teaching increases the permanence of information and facilitates its recall. For this reason, improving the design skills of teachers who will prepare concept cartoons that will appeal to as many senses as possible can be provided with various in-service training programs.

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