Canbulut, D. & Kılıç, R. (2022). Impact of educational comics on division concept in primary schools. *International Online Journal of Education and Teaching (IOJET), 9(4),* 1900-1915.

Received : 22.06.2022
Revised version received : 15.09.2022
Accepted : 20.09.2022

IMPACT OF EDUCATIONAL COMICS ON DIVISION CONCEPT IN PRIMARY SCHOOLS

Research article

Dürdane Canbulut https://orcid.org/0000-0002-1382-3255
Niğde ODTÜ Koleji, Turkey
simsekdurdane1905@gmail.com

Remzi Kılıç https://orcid.org/0000-0001-7806-3552
Niğde Ömer Halisdemir University, Turkey
remziklc@gmail.com

Biodatas:

Dürdane Canbulut, is working as a primary school teacher at Niğde ODTU GVO.

Remzi Kılıç is an assistant professor at Niğde Ömer Halisdemir University, Faculty of Education, Department of Basic Education. His areas of interest are teaching mathematics in primary school, measurement and evaluation in education, teacher training, learning processes and technology supported teaching.

IMPACT OF EDUCATIONAL COMICS ON DIVISION CONCEPT IN PRIMARY SCHOOLS

Dürdane Canbulut
simsekdurdane1905@gmail.com

Remzi Kılıç
remziklc@gmail.com

Abstract

Comics engage students in learning mathematics through their interactive nature and the relatively simple language they use. Not only that, it also helps expand students' thinking through the introduction of contextualized mathematics. This is also in line with the latest math education trend to engage students with math problems in a real-world context. As a result, there is a great potential for the use of comics as a teaching tool in primary school mathematics lessons. The current research works pointed out that comics increase the efficiency of teaching and strengthen the relationship between teacher and students. The purpose of this study is to determine the effect of educational comics-supported instruction on academic achievement of primary school students in division concept. The study used quasi-experimental design with pretest-posttest control group. The study group consists of 42 second grade pupils (21 for experimental and 21 for control group) studying in a public primary school located in Niğde, Turkey. As for data collection, academic achievement test was developed based on the learning outcomes of the mathematics curriculum. The pilot study was conducted to determine the statistics and the quality of test items. In order to ensure the validity of this test, evidences were collected and the reliability of the test calculated. The results of this study showed that the students who learn division via educational comics-supported instruction is more successful than the students who learn division via traditional instruction. Two of the reasons could be listed as (1) division is a complex and abstract concept so that traditional instruction have some difficulty in making the understanding easier, (2) educational comics strengthen the communication between student and teacher, attract attention of the students. This study is considered important in terms of emphasizing that educational comics are a preferred tool for some concepts of mathematics instruction.

Keywords: division, educational comics, elementary school, mathematics.

1. Introduction

Most of the masterpieces of civilization seen from industry to technology were created by mathematics. In addition, most of the societies developed in the field of science and technology are aware of the importance of a better mathematics education and mathematics in determining social life (Işık, Çiltaş & Bekdemir, 2008; Willoughby, 1990). Mathematics is the focus of life (Behrends, 2015) and crutial for all people to participate fully in society (National Research Council, 2001). Individuals would have begun to find solutions for the problems since early childhood (Baki, 2008). Therefore, primary school is the starting point of students' educational career, and student success at this level is of great importance when considering the later stages life (Turan, 2019). If mathematics teaching is not provided effectively in the first years of primary education, this would end up with learning problems for the student in the future. Therefore, mathematics would become inextricable for the student due to the chain progress of

the subjects (Kartallıoğlu, 2005). The basis of mathematics taught at primary school level is to enable students to acquire four operation skills, which consist of addition, subtraction, multiplication and division, which are constantly used in daily life (Ergün & Özdaş, 1997; Stein et al., 2005). Since the mathematical concepts encountered in the set of natural numbers are also encountered in other numbers, the teaching of natural numbers and operations with natural numbers is also the basis for teaching other number sets (Olkun & Toluk Uçar, 2018). Teaching four operations at a simple level is important for primary school students to take their mathematical skills to the next level (McCallum & Schmitt, 2011). Individuals who have not developed four processing skills will be inadequate in solving the problems they encounter in the future (Burns, 2007). At primary school level, division is one of the most difficult subjects among the four operations in terms of understanding the meaning of the concept (Ayvaz, 2010; Albayrak & Şimşek, 2017; Hickendorff, Torbeyns & Verschaffel, 2019). Especially in cases where the divisor has two or more digits, it is a very difficult process for some primary school students (Baykul, 2016). Division is first introduced in the second grade of primary school in most curriculum and is the main focus of third grade mathematics. In the following processes, the division process gains more weight in the programs (Van de Walle, Karp & Bay-Williams, 2014).

Today, the need for people who research, question, explore and solve problems increases considerably (Göksu & Köksal, 2016). Therefore, the current developments in the 21st century have led to a series of changes in our understanding of education. Meeting our teaching needs in our age has necessitated the preparation of teaching materials with a new perspective in the classrooms where modern education and teaching practices are carried out together. The way teachers present content affects students' understanding (Neumann, Kind & Harms, 2019). Because students have different learning styles, teachers should address as many senses as possible while teaching (Reid, 2005). One of the easiest and most effective ways to do this is to benefit from various teaching materials in the lessons. When teaching materials are used in appropriate conditions, they provide a multi-learning environment by appealing to different senses (Ak, Erdoğan & İlhan, 2020). In this direction, it is possible to talk about many positive effects of teaching materials used in the classroom, such as increasing efficiency, ensuring active participation of students (Tekmen, 2016) and providing permanent learning (Aşçı, 2020). In education, there are many effective materials that contain different forms of communication. The attractiveness of the pictures is a known fact, and especially the pictures associated with daily life have a very catchy quality (Koutníková, 2017). Among these tools, it can be stated that the type of material that is more compatible with written expression and visuality is comics (Yıldırım, 2016). Comics refer to media in which ideas (realistic or imaginary) are conveyed using images or a series of images, usually cartoons. They are a designed visual art that includes humor while conveying important messages (Toh et al., 2017). Comics, which are defined as limitless fantasy world and extraordinary, are the ones that convey a great number of issues, from heroes with supernatural abilities to cleaning the world from bad guys, to social events, together with humor, horror and tension elements (Özyiğit, 2010). Comics are more qualified than videos in that they allow the individuals to create their free world (Ceran, 2014). Although comics give the impression of creating a magical fantasy realm, they actually create a realm very similar to the real world (İlhan, 2016). The unique features of the comic book have made it an independent art, as well as attracting high attention in the process and highlighting it as a useful material in the teaching-learning processes (Kavak & İlhan, 2021).

Given that children are visually oriented by nature, the humor and empathy of comics make it a suitable methodological tool for acquiring new learning materials (Lazzarich, 2013).

Comics have been an important mass media tool in the process from their emergence to the present day. Therefore, they are very suitable for use in today's classroom environments for teachers who want to benefit from an unusual and remarkable material (Çelik & İlhan, 2021; Şentürk, 2020). The use of comics in print for educational purposes started in the USA in the middle of the 20th century, and this trend spread worldwide in the following years (Symeon, 2008). With their narratives and visuals, comics facilitate learning, encourage imagination, support development and improve logical thinking skills (Morel et al., 2019). The use of comics in education is based on the concept of creating engagement and motivation for students. Comics allow children to interact with both text and images to create meaning. Studies have shown that comics have become very effective teaching materials in many developed countries because they convey a large amount of information in a short time (Subramaniam, 2016). Feedback from teachers showed that students were more motivated to learn the subject through the use of cartoons and comics (Toh, 2009). Research on reading interests and preferences provides evidence that comics have a special appeal to school-age children (Wright & Sherman, 2006). Using alternative methods such as comics to enable students to construct knowledge creates a richer understanding of concepts that can be applied to real learning environments. By promoting such innovative methods in teaching, educators can transform theory from an intellectual exercise into a pedagogical tool for critical thinking and instructional decision-making (Bolton-Gary, 2012). As time progressed, it was seen that studies on the educational aspect of comics increased, and the positive results of these studies led researchers to direct them to comics in new and different fields (İlhan, 2016). Topkaya and Yılar (2015) examined the students' views on comics and concluded that the messages intended to be given in this way were presented in a short and clear way, that the students identified with the characters of the comics and that the comics increased the interest in the lesson. Topkaya (2014), on the other hand, is of the opinion that the first of the features that lead educators to use comics is to motivate students to the lesson comfortably.

1.1.Purpose

In the related literature, there are numerous studies relating educational comics with social sciences (Ak, Erdoğan & İlhan, 2020; Çelik & İlhan, 2021; İlhan, 2016; İlhan, Kaba & Sin, 2021; İlhan & Oruç, 2019; Kavak & İlhan, 2021; Richter, Randings & Maminirina, 2015; Şentürk, 2020; Topkaya, 2014; Topkaya, 2016; Topkaya & Yılar, 2015; Ünal & Demirkaya, 2019), with natural sciences (Affeldt, Meinhart & Eilks, 2018; Hosler & Boomer, 2011; Lin & Lin, 2016; Morel, Peruzzo, Juele & Amarelle, 2019; Olson, 2008; Spiegel et al., 2013) and with language teaching (Ekinci Efecioğlu, 2013; Işıkyıldız, 2011; Üstün & Pilav, 2016). The number of studies in mathematics teaching is limited (Chu & Toh, 2020; Şengül & Dereli, 2010; Toh, et al., 2017; Toh, 2009). In addition, Wallner and Eriksson Barajas (2020) reviewed 55 studies on comics and concluded that the studies tended to focus on qualitative interview studies in which a group of students introduced materials and evaluated their experiences. They have seen that most of the researches are directed towards determining the text preferences of the students either by measuring the comics according to the traditional texts or by asking the students their opinions about certain comic texts. Most importantly, they emphasize that it is still unclear whether students learn more from comics.

No study has been found on the use of comics in the teaching of division, which is one of the most difficult subjects for primary school students to embody. Therefore, this situation constitutes the main motivation of the study. For this reason, it is thought that an important contribution will be made to the literature by determining the effect of teaching activities to be carried out with comics on the division process on student success. In this direction, the

problem sentence of the study is determined as “How effective are educational comics on academic success in the division process?”. The research questions can be listed as follows.

RQ1. Is there a significant difference between the pre-test scores of the experimental and control group students?
RQ2. Is there a significant difference between the pre-test and post-test scores of the experimental group students?
RQ3. Is there a significant difference between the pre-test and post-test scores of the control group students?
RQ4. Is there a significant difference between the post-test scores of the experimental and control group students?

2. Method

2.1. Research Design

This study was carried out using a quasi-experimental design to determine the effect of instructional comics-supported instruction on academic achievement. Within this form it is not a true experimental research as the participants are not randomly assigned to groups (Gribbons & Herman, 1996). In such designs, while the experimental group is exposed to the independent variable, the control group is not affected by the independent variable. In this design, a measurement about the dependent variable is made to the groups before and after the process. Including the pre-test in the model is important in terms of knowing the equivalence of the groups before the application and comparing the post-test results (Karasar, 2016). The research model of this study is indicated in Figure 1.

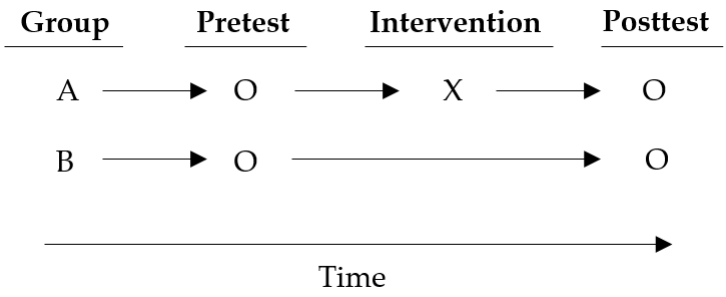

Figure 1. Research model of the study

As shown in Figure 1, the academic achievement of second-grade students in division is measured once before intervention and once after. Here, group A is the experimental and group B is the control group. In intervention, X stands for the treatment in education comics-supported instruction in division.

2.2. Study Group

The study group of the research consists of 42 second grade students studying in a public primary school in the city center of Niğde and in two different branches. There are six second grade branches in the primary school. Since three of these branches had already started the division process, it was decided to determine the experimental and control groups among the remaining three branches. An academic achievement test was applied to three branches who did not start the division process, and depending on the data obtained, two equal groups were

randomly assigned as the experimental and control group. The results of the analysis performed to determine the groups are given in Table 1.

Table 1. *Kruskal Wallis-H test results for comparison of the pre-test scores of groups*

Instrument	Branch	f	Mean rank	Kruskall Wallis H	df	p
Academic achievement test	B	21	28.00	8.682	2	.013
	C	21	27.86			
	F	23	42.26			

In Table 1, the results of the Kruskal Wallis-H test, which was conducted to compare the academic achievement test pre-test scores of second grade students, are given. Accordingly, it was determined that there was a statistically significant difference between the groups in the results of the academic achievement test ($p<.05$). Mann Whitney U Test was performed to determine between which branches the difference between the groups was and the results are given in Table 2.

Table 2. *Mann Whitney U test results for the comparison of the pre-test scores of groups*

Branch	f	Mean rank	Sum of ranks	U	z	p
B	21	21.62	454.00	218.00	-.063	.949
C	21	21.38	449.00			
B	21	17.24	362.00	131.00	-2.623	.009
F	23	27.30	628.00			
C	21	17.62	370.00	139.000	-2.429	.015
F	23	26.96	620.00			

According to Table 2, when pre-test scores of the achievement test were compared, there was no statistically significant difference between the B and C branches ($U=218.00$ $p>.05$), B and F branches ($U=131.00$ $p<.05$) and C and F branches ($U=139.00$ $p<.05$) a significant difference was determined. Therefore, we decided to choose B and C branches from two equivalent branches as the study group. After random selection, branch C was assigned as experimental and branch B was assigned as control group.

2.3. Data Collection Tools

In order to determine students' achievement in division, the researchers need "academic achievement test" for division.

2.3.1. Academic Achievement Test

The academic achievement test consists of 15 multiple-choice items with three options. For the achievement test, firstly, a pool of 21 items was created, and the scope and face validity was ensured by taking expert opinions. Then, a pilot application was made to a group (n=137) similar to the students to whom the main application would be made, and those who could not fulfill their function as a result of the validity-reliability analyzes (item discriminations; .18, .14, .03, .14, .17 and -.04). After discarding these items, the final test forms were obtained. The

mean item difficulty of the items was 0.71, and the mean item discrimination was 0.52. Finally, the KR-20 reliability for the academic achievement test was calculated as .82. In line with these analysis, it can be said that the validity and reliability of the data collection tool is at a sufficient level.

2.4. Preparation and Application Process of Instructional Material

Regarding the implementation of the study, application permissions were obtained from the relevant institutions, including the Directorate of National Education.

Educational comics were prepared by the researchers before the application. In this context, a scenario was prepared for all the achievements of the research subject and these scenarios were examined by expert academics in terms of subject area, language and meaning, and educational comics were finalized in line with the feedbacks.

In the research, four educational comic book fascicles were used. These fascicles were prepared in accordance with the division process gains. Below is a sample page from the comic book fascicles used in the teaching of the division process (Figure 2) and a sample image from the application process (Figure 3).

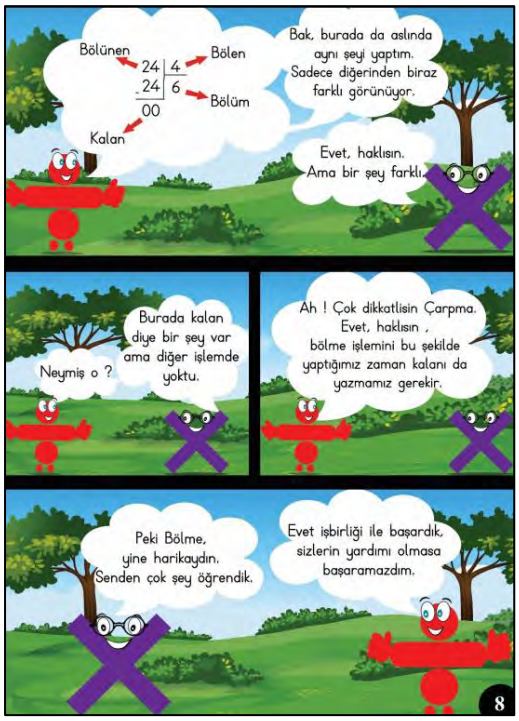

Figure 2. Example of Comic Book Page

Figure 3. Visual for the Implementation Process

The research was carried out for 4 weeks and a total of 16 course hours. While the lessons of the experimental group were carried out by the class teacher with educational comics-supported activities within the framework of the lesson plans and materials prepared by the researcher, the lessons of the control group were carried out by the instructional activities organized according to the curriculum by the teacher.

2.5. Data Analysis

The data obtained in the study were analyzed using the SPSS program. Having more than thirty observations in the groups allows to obtain statistically more robust data. If the population distributions are not normal and the number of observations is less than thirty, it would be more appropriate to apply non-parametric tests (Alpar, 2014). In this direction, it was examined whether the data were normally distributed and the analyzes in the following processes were carried out in this direction. According to the results of the normality test regarding the distribution of the pretest-posttest data of the students in the experimental and control groups, the skewness and kurtosis values calculated. Since it was not between -1 and +1, it was determined that the control group, pre-test and post-test values did not show normal distribution (Hair et al., 2013). In addition, non-parametric tests were preferred in the analyzes due to the fact that the number of observations in the groups was less than thirty (Alpar, 2014; Baykul & Güzeller, 2014). In this direction, the Mann Whitney U Test was used to compare the pretest and posttest scores of the students in the experimental and control groups between the groups. The Wilcoxon Signed Rank Test was used to compare the pre-test and post-test scores of the experimental group and control group students within the group.

3. Findings

This part interprets the findings of the analyses based on the research questions. The first question focuses on the difference between the pre-test scores of experimental and control group students. Mann Whitney U test results are given in Table 3.

Table 3. *Mann Whitney U test results for comparing pre-test scores*

Group	f	Mean rank	Sum of ranks	U	p
Experimental	21	21.38	449.00	218.00	.949
Control	21	21.62	454.00		

According to Table 3, it was determined that there was no significant difference between the pre-test scores of the experimental and control group students (U= 218.00, p> .05). While the academic achievement test pretest mean rank of the students in the experimental group was 21.38, the mean rank of the students in the control group was 21.62. According to this, it can be said that the academic achievement levels of the students in the experimental and control groups are about equal.

The second problem is about the difference between pre-test and post-test scores of experimental group students. Accordingly, the results of Wilcoxon Signed Rank test are presented in Table 4.

Table 4. *Wilcoxon Signed Rank test results for comparing pretest and posttest scores of experimental group*

Pretest-Posttest	f	Mean rank	Sum of ranks	z	p
Negative	00[a]	.00	.00	3.926	.000
Positive	20[b]	10.50	210.00		
Equal	1[c]				

In Table 4, Wilcoxon Signed Ranks test results for the comparison of the pretest and posttest scores of the experimental group students are given. Accordingly, it was determined that there was a statistically significant difference between the pre-test and posttest scores of the students (z= 3.926, p<.001). Considering the mean rank and rank totals of the scores, it is seen that this

difference is in favor of the posttest scores. Accordingly, the posttest score rank of 20 students in the experimental group increased significantly compared to pretest score rank of this group. However, the rank of 1 student keeps the same when the pretest and posttest rank scores are considered. Based on these results, it can be said that the educational comics-supported activities positively affect the academic success of the students in the division process.

The third question is about the difference between the pretest and posttest scores of the control group students. The result of Wilcoxon signed rank test is given in Table 5.

Table 5. *Wilcoxon signed rank test results for the comparison of the pretest and posttest scores of the control group*

Pretest-Posttest	f	Mean rank	Sum of ranks	z	p
Negative	0[a]	.00	.00	3.932	.000
Positive	20[b]	10.50	210.00		
Equal	1[c]				

Based on the statistics given in Table 5, it was determined that there was a statistically significant difference between the pretest and posttest scores of control group students (z= 3.932, p<.001). By considering the mean rank and rank totals of the scores, it is seen that this difference is in favor of the posttest scores. Accordingly, it was determined that the posttest score rank of 20 students in the control group increased significantly compared to their pretest score ranks. Moreover, the rank of 1 student are equal when the pretest and posttest rank scores are compared. When the results are examined, we can say that the activities carried out with traditional applications based on the curriculum affect the academic success of the students in the division process positively.

The fourth question of the study examines the difference between posttest scores of experimental and control group students. The result of Mann Whitney U test is figured out in Table 6.

Table 6. *Mann Whitney U test results for comparing post-test scores*

Group	f	Mean rank	Sum of ranks	U	p
Experimental	21	25.40	533.50	138.50	.031
Control	21	17.60	369.50		

According to the values given in Table 6, it was determined that there was a significant difference between the posttest scores of the experimental and control group students in favor of the experimental group (U= 138.50, p< .05). While the academic achievement test pretest mean rank of the students in the experimental group was 25.40 and the total rank was 533.50, the rank average of the students in the control group was 17.60 and their rank total was 369.50. According to these findings, it can be said that the education comics-supported instruction in division given to the experimental group is more effective than the traditional instruction applied to the control group.

4. Discussion, Conclusion and Recommendations

This study focused on determining the effect of educational comics-supported instruction on academic achievement of primary school students in division concept. The results are interpreted below by taking into account the relevant literature. The first research question reveal that there is no significant difference between the pretest scores of the students in the experimental and control group. In other words, it can be said that the academic achievement levels of the students in the experimental and control groups, which make up the study group, were equivalent to each other before the application.

The second question of the study aims to reveal the differentiation between pretest and posttest scores of the students in the experimental group, and the third sub-problem is to reveal the differentiation between the pretest and posttest scores of the students in the control group. Accordingly, the findings reveal that there is a significant difference in favor of posttest scores in both groups. This situation coincides with the results of experimental research on mathematics teaching, operation teaching and especially division (Ayvaz, 2010; Bahadır & Özdemir, 2013; Bakker, 2014; Bozkurt & Polat, 2011; Köroğlu & Yeşildere, 2004; Muşlu & Skinaş, 2016; Tuncer & Şimşek, 2019; Uskun Aytekin, Çil & Kuzu, 2021; Yıkmış & Çetin, 2010). This finding shows that interventions on the subject of division have an increasing effect on students' academic achievement levels in both groups.

When the posttest scores of the students in the experimental and control groups were compared, it was determined that there was a significant difference between the academic achievement scores of the groups in the division process in favor of the experimental group. According to this result, it can be said that the educational comics supported instruction applied in the teaching of the second grade division process in primary school is more effective than the instruction carried out with traditional activities based on the curriculum. This finding shows that the effect of educational comics on academic achievement is examined (Çiçek Şentürk, 2020; Ekinci Efecioğlu, 2013; Hosler & Boomer, 2011; İlhan, 2016; Işıkyıldız, 2011; Kaba, 2021; Olson, 2008; Orçan, 2013; Özdemir, 2010; Popa & Tarabuzan, 2015; Şentürk, 2020; Topkaya, 2014; Topkaya, 2016; Ünal & Demirkaya, 2019; Üstün & Pilav, 2016) also overlap with other findings in the relevant literature. We also came across research results in the literature which reveal that educational comics do not have a significant effect on academic achievement (Lin & Lin, 2016). However, Chu & Toh (2020) stated that using comics while teaching mathematics to primary school students would help create an interesting and favorable learning environment, especially in the acquisition of relatively challenging topics and difficult mathematical concepts in the program, and may be more effective than traditional mathematics textbooks. Toh, et al., (2017) in their study conducted in Singapore, concluded that comics are promising in increasing students' mathematical understanding.

Comics engage students in learning mathematics through their interactive nature and the relatively simple language they use. Not only that, it also helps expand students' thinking through the introduction of contextualized mathematics. This is also in line with the latest math education trend to engage students with math problems in a real-world context. As a result, there is a great potential for the use of comics as a teaching tool in primary school mathematics lessons (Chu & Toh, 2020). Lazzarich (2013) determined that comics increase the efficiency of teaching and strengthen the relationship between teacher and students. Şentürk (2020) stated that educational comics help students to understand the lesson more easily, increase their motivation, interest and attention towards the lesson, strengthen the communication between the student and the teacher, attract attention, make the lesson fun, and provide concrete examples of abstract concepts with their visual elements. It would have positive effects on

students' academic achievement due to its features such as encouraging students to think actively and improving their thinking skills. As a result, educational comics can be used as an effective course material in the teaching of complex and abstract concepts inherent in mathematics.

In the light of the findings and results obtained in this study, the following recommendations could be made: (1) educational comics can be included in the curriculum as a new teaching material because they are suitable for children's psychological and developmental characteristics, (2) educational comics on different subjects can also be created by teachers, and such visual materials can be given more space in the classrooms, (3) studies can also be conducted on the experiences of teachers on the use of educational comics as teaching materials and (4) related studies can be conducted to determine the effect of educational comics on different variables in different grade levels and different courses.

References

Affeldt, F., Meinhart, D., & Eilks, I. (2018). The use of comics in experimental instructions in a non-formal chemistry learning context. *International Journal of Education in Mathematics, Science and Technology, 6*(1), 93-104. http://dx.doi.org/10.18404/ijemst.380620

Ak, M. M., Erdoğan, M. F. & İlhan, G. O. (2020). Görsel Bir Öğretim Materyali Olarak Dijital Çizgi Roman Tasarımı: Gezdim, Gördüm, Öğrettim. *Journal of History School, 47*, 2458-2484. http://dx.doi.org/10.29228/Joh.44172

Akcanca, N. (2020). An alternative teaching tool in science education: Educational comics. *International Online Journal of Education and Teaching (IOJET), 7*(4). 1550-1570. http://iojet.org/index.php/IOJET/article/view/1063

Albayrak, M. & Şimşek, M. (2017). Yetişkinlerin davranışlarını değiştirmenin güçlüğü: Bölme örneği. *Erzincan Üniversitesi Eğitim Fakültesi Dergisi, 19*(1), 184-198. http://dx.doi.org/10.17556/erziefd.308694

Alpar, R. (2014). Spor, Sağlık ve Eğitim Bilimlerinden Örneklerle Uygulamalı İstatistik ve Geçerlik-Güvenirlik. 3. Baskı. Ankara: Detay Yayıncılık.

Aşçı, A. U. (2020). Examining the comic strips which takes places on the texts on secondary school Turkish language course books in terms of education of values. *The Journal of International Social Research, 13*(69), 868-889. http://dx.doi.org/10.17719/jisr.2020.4006

Ayvaz, A. (2010). *4. sınıf matematik dersi bölme işlemi alt öğrenme alanının edebî ürünlerle işlenmesinin öğrenci başarısı ve tutumuna etkisi.* (Yayımlanmamış Yüksek Lisans Tezi). Sakarya Üniversitesi, Sosyal Bilimler Enstitüsü, Sakarya.

Bahadır, E., & Özdemir, A. Ş. (2013). Tam sayılar konusunun canlandırma tekniği ile öğretiminin öğrenci başarısına ve hatırlama düzeyine etkisi. *International Journal Social Science Research, 2*(2), 114-136.

Baki, A. (2008). Kuramdan uygulamaya matematik eğitimi, Harf Eğitim Yayıncılık, 4. Baskı. Ankara.

Bakker, M. (2014). *Using mini-games for learning multiplication and division: A longitudinal effect study.* (Doctoral dissertation). Utrecht University.

Baykul, Y. (2016). İlköğretimde Matematik Öğretimi (13.Baskı). Ankara: Pegem Akademi Yayınları

Baykul, Y. & Güzeller, C.O. (2014). Sosyal bilimler için istatistik spss uygulamalı. Ankara: Pegem Akademi Yayıncılık.

Behrends, E. (2015). Five minute mathematics. Palme Yayıncılık, Ankara.

Bolton-Gary, C. (2012). Connecting through comics: Expanding opportunities for teaching and learning. *US-China Education Review B, 4*, 389–395.

Bozkurt, A., & Polat, M. (2011). Sayma Pullarıyla Modellemenin Tam Sayılar Konusunu Öğrenmeye Etkisi Üzerine Öğretmen Görüşleri. *Gaziantep University Journal of Social Sciences, 10*(2).

Burns, M. (2007). About teaching mathematics: A K-8 resource (3 ed.). Sausalito, CA: Math Solution Publications.

Ceran, K. (2014). Çizgi roman nedir çizgili hayat kılavuzu. Derleyen Levent Cantek, İstanbul: İletişim Yayınları.

Chu, Y. L. L. & Toh, T. L. (2020). A framework for designing mathematics instruction using comics at the primary school level. *JRAMathEdu (Journal of Research and Advances in Mathematics Education), 5*(3), 218230. https://doi.org/10.23917/jramathedu.v5i3.11373

Çelik, K. & İlhan, G. O. (2021). Çocuk haklarına yönelik eğitici çizgi roman: "Sadece Biriyim". *Türkiye Eğitim Dergisi, 6*(1), 262-279.

Çiçek Şentürk, Ö. (2020). *Argümantasyon destekli eğitici çizgi romanların öğrencilerin çevreye yönelik ilgi, motivasyon ve akademik başarılarına etkisi ile öğrenci deneyimleri.* (Doktora Tezi). Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara.

Ekinci Efecioğlu, E. (2013). *The role of graphıc novels ın teachıng englısh as a foreıgn language.* (Yayımlanmamış Yüksek Lisans Tezi). Hacettepe Üniversitesi, Sosyal Bilimler Enstitüsü, Ankara.

Ergün, M., & Özdaş, A. (1997). Öğretim ilke ve yöntemleri. İstanbul: Kaya Matbaacılık.

Göksu, F. C. & Köksal, N. (2016). Doğrular, açılar ve çokgenler konularının kavram karikatür destekli yapılandırmacı öğrenme yaklaşımına göre işlenmesi. *Journal of Qualitative Research in Education, 4*(3), 68-91. https://doi.org/10.14689/issn.2148-2624.1.4c3s4m

Güleryüz, H. (2003). Yaratıcı çocuk edebiyatı. Ankara: Pegem Akademi.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2013). Multivariate Data Analysis: Pearson Education Limited.

Hickendorff, M., Torbeyns, J., & Verschaffel, L. (2019). Multi-digit addition, subtraction, multiplication, and division strategies. In International handbook of mathematical learning difficulties (pp. 543-560). Springer, Cham.

Hosler, J., & Boomer, K. B. (2011). Are comic books an effective way to engage nonmajors in learning and appreciating science? *CBE—Life Sciences Education, 10*(3), 309-317. https://doi.org/10.1187/cbe.10-07-0090

Hutchinson, K. H. (1949). An experiment in the use of comics as instructional material. *The Journal of Educational Sociology, 23*(4), 236-245.

Işık, A. , Çiltaş, A. & Bekdemir, M. (2008). Matematik eğitiminin gerekliliği ve önemi. *Kazım Karabekir Eğitim Fakültesi Dergisi, 17*(2008), 174-184.

Işıkyıldız, M. (2011) *Çizgi romanların yabancı dil olarak fransızca öğretimindeki yeri.* (Yayımlanmamış Yüksek Lisans Tezi). Hacettepe Üniversitesi, Sosyal Bilimler Enstitüsü, Ankara.

İlhan, G. (2016). *Sosyal bilgiler öğretiminde çizgi romanların kullanımı.* (Yayımlanmamış Doktara Tezi). Afyon Kocatepe Üniversitesi, Sosyal Bilimler Enstitüsü, Afyon.

İlhan, G. O., & Oruç, Ş. (2019). Sosyal bilgiler dersinde çizgi roman kullanımı: Teksas tarihi. *Eğitim ve Bilim, 44*(198). http://dx.doi.org/10.15390/EB.2019.7830

İlhan, G. O., Kaba, G., & Sin, M. (2021). Usage of digital comics in distance learning during COVID-19. *International Journal on Social and Education Sciences (IJonSES), 3*(1), 161-179. https://doi.org/10.46328/ijonses.106

Kaba, G. (2021). *Sosyal bilgiler dersinde müze eğitimine yönelik geliştirilen dijital çizgi romanın öğrencilerin akademik başarısına ve tutumuna etkisi.* (Yayımlanmamış Yüksek Lisans Tezi). Yıldız Teknik Üniversitesi, Eğitim Bilimleri Enstitüsü, İstanbul.

Karasar, N. (2016). Bilimsel Araştırma Yöntemi (31. Baskı). Ankara: Nobel Yayınları.

Kartallıoğlu, S. (2005). *İlköğretim 3 ve 4.sınıf öğrencilerinin sözel matematik problemlerini modellemesi: çarpma ve bölme işlemi.* (Yayımlanmamış Yüksek Lisans Tezi). Abant İzzet Baysal Üniversitesi, Sosyal Bilimler Enstitüsü, Bolu.

Kavak, O. & İlhan, G. O. (2021). Sosyal bilgiler dersi etkin vatandaşlık öğrenme alanına yönelik dijital çizgi roman tasarımı: "Minik Vatandaşlar". *Öğretmen Eğitiminde Yenilikçi Araştırmalar Dergisi, 2*(3), 243-265. https://doi.org/10.29329/jirte.2021.408.5

Koutníková, M. (2017). The application of comics in sience education. *Acta Educationis Generalis,7* (3), 89-90. https://doi.org/10.1515/atd-2017-0026

Köroğlu, H. & Yeşildere, S. (2004). İlköğretim matematik dersi tamsayılar ünitesinde çoklu zekâ teorisi tabanlı öğretimin öğrenci başarısına etkisi. *Gazi Üniversitesi Eğitim Fakültesi Dergisi, 24*(2), 25-41.

Lazzarich, M. (2013). Comic strip humour and empathy as methodological ınstruments in teaching. *Croatian Journal of Education, 15*(1), 153-190. https://hrcak.srce.hr/100094

Lin, S. F., & Lin, H. S. (2016). Learning nanotechnology with texts and comics: The impacts on students of different achievement levels. *International Journal of Science Education, 38*(8), 1373-1391. http://dx.doi.org/10.1080/09500693.2016.1191089

McCallum, E., & Schmitt, A. J. (2011). The taped problems intervention: Increasing the math fact fluency of a student with an intellectual disability. *International Journal of Special Education, 26*(3), 276-284.

Morel, M., Peruzzo, N., Juele, A. R., & Amarelle, V. (2019). Comics as an educational resource to teach microbiology in the classroom. *Journal of Microbiology & Biology Education, 20*(1), 10. https://doi.org/10.1128/jmbe.v20i1.1681

Muşlu, M., & Çiltaş, A. (2016). Doğal sayılarda işlemler konusunun öğretiminde matematiksel modelleme yönteminin öğrenci başarısına etkisi. *Bayburt Eğitim Fakültesi Dergisi, 11*(2).

National Research Council, (2001). Adding it up: Helping children learn mathematics. J. Kilpatrick, J. Swafford, and B. Findell (Eds.). Mathematics Learning Study Committee, Center for Education, Division of Behavioral and Social Sciences and Education. Washington, DC: National Academy Press.

Neumann, K., Kind, V., & Harms, U. (2019). Probing the amalgam: the relationship between science teachers' content, pedagogical and pedagogical content knowledge. *International Journal of Science Education, 41*(7), 847-861. https://doi.org/10.1080/09500693.2018.1497217

Olkun S. & Toluk Uçar Z. (2018) İlköğretimde Etkinlik Temelli Matematik Öğretimi. Vizetek Yayıncılık, Ankara (8. Baskı).

Olson, J.C. (2008). *The comic strip as a medium for promoting science literacy*. (Master's Thesis). California State University.

Orçan, A. (2013). *Çizgi roman tekniği ile geliştirilen bilim kurgu hikâyelerinin öğrencilerin yaratıcı düşünme becerilerinin ve fiziğe ilişkin tutumlarının gelişimine etkisi.*

(Yayımlanmamış Yüksek Lisans Tezi). Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara.

Özdemir, E. (2010). *The effect of instructional comics on sixth grade students' achievement in heat transfer*. (PhD Thesis). Middle East Technical University.

Özyiğit, C. (2010).*Tüketim mallarında çizgi roman kahramanlarının kullanılmasının marka bilinirliğine etkisi.* (Yayımlanmamış Yüksek Lisans Tezi). Ege Üniversitesi, Sosyal Bilimler Enstitüsü, İzmir.

Popa, N. L., & Tarabuzan, E. O. (2015). Using comic strips in teaching and learning French as foreign language: Changes in motivational beliefs. *Review of Artistic Education, 9*(10), 273-278.

Reid, G. (2005). Learning styles and inclusion. Sage.

Richter, T., Rendigs, A., & Maminirina, C. P. (2015). Conservation messages in speech bubbles–evaluation of an environmental education comic distributed in elementary schools in Madagascar. *Sustainability, 7*(7), 8855-8880. https://doi.org/10.3390/su7078855

Spiegel, A. N., McQuillan, J., Halpin, P., Matuk, C., & Diamond, J. (2013). Engaging teenagers with science through comics. *Research in Science Education, 43*(6), 2309-2326. https://doi.org/10.1007/s11165-013-9358-x

Stein, M., Kinder, D., Silbert, J., & Carnine, D. W. (2005). Designing effective mathematics instruction: A direct instruction approach. Pearson.

Subramaniam, V. (2016). Make more use of comics in Schools. Retrieved from: https://www.straitstimes.com/forum/letters-in-print/make-more-use-of-comics-in-teaching

Symeon, R. (2008). State of the art comics in education. Using Web Comics in Education. Project Deliverable Report. Retrieved from https://silo.tips/download/project-deliverable-report-deliverable-nr-d1-state-of-the-art-comics-in-educatio

Şengül, S., & Dereli, M. (2010). Does instruction of "Integers" subject with cartoons effect students' mathematics anxiety? *Procedia-Social and Behavioral Sciences, 2*(2), 2176-2180. https://doi.org/10.1016/j.sbspro.2010.03.302

Şentürk, M., (2020). *Sosyal bilgiler dersinde eğitici çizgi roman ve eğitici çizgi film kullanımının öğrencilerin, tutum, motivasyon ve akademik başarılarına etkileri.* (Doktora Tezi). Atatürk Üniversitesi, Eğitim Bilimleri Enstitüsü, Erzurum.

Tekmen, B. (2016). Theoretical foundations of teaching materials. In N. Ültay & E. Ültay (Eds.), Teaching techniques and material development for preschool education (pp. 42-58). Ankara: Pegem Academy.

Toh, T. L., Cheng, L. P., Ho, S. Y., Jiang, H. & Lim, K. M. (2017) Use of comics to enhance students' learning for the development of the twenty-first century competencies in the mathematics classroom. *Asia Pacific Journal of Education, 37*(4), 437-452. https://doi.org/10.1080/02188791.2017.1339344

Toh, T. L. (2009). Use of cartoons and comics to teach algebra in mathematics classrooms. In D. Martin, T. Fitzpatrick, R. Hunting, D. Itter, C. Lenard, T. Mills& L. Milne (Eds.)Mathematics of prime importance: MAV yearbook 2009 (pp. 230–239). Melbourne: The Mathematical Association of Victoria.

Topkaya, Y. & Yılar, B. (2015). Analysis student views related to educative comics. *Route Educational and Social Science Journal, 2*(3), 106-117. http://dx.doi.org/10.17121/ressjournal.333

Topkaya, Y. (2014). Vatandaşlık ve demokrasi eğitimi dersinde eğitici çizgi roman kullanımının bilişsel ve duyuşsal öğrenmelere etkisi. (Doktora Tezi). Atatürk Üniversitesi, Eğitim Bilimleri Enstitüsü, Erzurum.

Topkaya, Y. (2016). Doğal çevreye duyarlılık değerinin aktarılmasında kavram karikatürleri ile eğitici çizgi romanların etkililiğinin karşılaştırılması. *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 13*(34).

Tuncer, M., & Şimşek, M. (2019). Ortaokul 5. sınıf matematik dersi bölme işlemi konusunda plickers uygulamasının matematik kaygısına ve matematik başarısına etkisi. *OPUS International Journal of Society Researches, 13*(19), 281-310. https://doi.org/10.26466/opus.578149

Turan, B. N. (2019) *Mobil uygulama destekli öğretimin ilkokul öğrencilerinin kesirler konusundaki akademik başarılarına etkisi.* (Yayımlanmamış Yüksek Lisans Tezi). Niğde Ömer Halisdemir Üniversitesi, Eğitim Bilimleri Enstitüsü, Niğde.

Uskun Aytekin, K., Çil, O. & Kuzu, O. (2021). Gerçekçi matematik eğitiminin dört işleme yönelik problem kurma ve çözme becerisi ile akademik başarıya etkisi. *Journal of Qualitative Research in Education, 28*, 22-50. https://doi.org/10.14689/enad.28.2

Ünal, O. & Demirkaya, H. (2019). A semi-experimental study on the use of educational comics in social studies. *International Journal of Geography and Geography Education (IGGE), 40*, 92-108. https://doi.org/10.32003/iggei.569650

Üstten, A. & Pilav, S. (2016). Temel seviyede yabancı dil olarak Türkçe öğretiminde çizgi romanların öğrenme düzeyine etkisi. *Ana Dili Eğitimi Dergisi, 4*(4), 599-606. https://hdl.handle.net/20.500.12587/777

Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2014). Elementary and middle school mathematics teaching developmentally. London: Pearson Education UK.

Wallner, L., & Eriksson Barajas, K. (2020). Using comics and graphic novels in K-9 education: An integrative research review. *Studies in Comics, 11*(1), 37-54. https://doi.org/10.1386/stic_00014_1

Willoughby, S. (1990). Mathematics education for a changing world. ERİC (ED327378)

Wright, G., & Sherman, R. B. (2006). Comics redux. *Reading Improvement, 43*(4), 165-173.

Yıkmış, A., & Çetin, M. E. (2010). Zihinsel yetersizliği olan öğrencilere sabit bekleme süreli öğretimle bölme öğretimi. *Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi, 10*(2), 69-78.

Yıldırım, E. (2016). Sınıf öğretmeni adaylarının eğitici çizgi roman hakkındaki görüşlerinin incelenmesi. *Sosyal Bilimler Dergisi, 6*(11), 52-70.