

Croatian Journal of Education
Vol.16; Sp.Ed.No.3/2014, pages: 109-131
Original research paper
Paper submitted: 7th October 2012
Paper accepted: 20th April 2013

Reflections from the Process of Game-Based Teaching of Probability

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Abstract

The aim of this study is to determine what happens when the subject of probability is taught via educational games. Participants in the research were fourth-grade students (N= 24, aged 9-10) who were taught for 3 class hours (each 40 minutes) by their teacher. The designed games were played among groups of 3-4 students. Data was gathered from 8 selected students' responses to semi-structured interviews, the teacher's views about the process, researchers' evaluations of students' reflections, students' journal entries regarding the process, and audio and video recordings of students' interactions. The findings were presented according to data collection sources. Evidence suggested that game-based teaching facilitated understanding, enhanced students' participation and motivation, enabled them to work with peers, helped them overcome math anxiety, provided an amusing learning environment, although it also resulted in classroom management difficulty and a noisy learning environment.

Key words: cooperative learning; game-based teaching; mathematics education; opinions of teacher and students; probability.

Introduction

Games have always played a significant role in mathematics learning as they encourage logico-mathematical thinking (Kamii & Rummelsburg, 2008), contribute to the development of knowledge while having a positive influence on the affective or emotional component of learning situations (Booker, 2000), can raise students' interest levels and motivation (Bragg, 2007), provide a unique opportunity for integrating cognitive, affective and social aspects of learning (Pulos & Sneider, 1994; Rieber, 1996) and can also improve young children's knowledge of numbers (Kumar &

Lightner, 2007). Moreover, it can be clearly stated that especially through educational games, students will have the opportunity to learn in a more flexible environment, in collaboration with their peers and will be engaged in active learning. Literature shows that one of the most important factors contributing to the process to be effective in such learning environments is argumentation (Sfard et al., 1998; Yackel, 2002). Argumentation helps students learn together, express their ideas easily, explain and justify their reasoning, and develop mathematical language.

Cooperative Learning in Small Groups

Prior research mentioned the benefits of the cooperative learning approach, including motivating students to learn mathematics by showing them ways to enjoy mathematics (Johnson & Johnson, 1989), helping them focus on the subject or task and to work with each other and providing a comfortable environment (Slavin, 1996), and enabling students to communicate with other members of group more effectively (Martino & Johnson, 1979). Similarly, a great number of other studies (Burguillo, 2010; Hamalainen, 2008; Hänze & Berger, 2007; Toumasis, 2004; Vasileiadou, 2009) have supported the creation of cooperative learning environments for effective instructions. As understood from this literature, organizing students as cooperative learning groups will help them benefit more from the process. Having instructions in such learning environments, where students argue with each other about valid arguments in mathematics, could be the core of mathematics teaching (Sfard et al., 1998). Thus, it can be said that students' argumentation play an important role in the occurrence of such positive effects in cooperative learning groups.

Why Game-Based Teaching?

In Turkey, students have their first formal teaching of probability in grade 4 (ages 9-10). Recent studies show that young children at this age can identify the most/least likely outcomes (Nikiforidou & Pange, 2010; Way, 2003) and distinguish "certain", "impossible" and "possible" events (Jones et al., 1997). Andrew (2009) states that concepts in probability can be more readily understood if students are first exposed to probability via experiments. According to Andrew, (1) performing experiments helps students differentiate between the elements of the sample space and a specific outcome of interest, the 'success' outcome, (2) performing an experiment a great number of times can demonstrate to students the likelihood of certain types of outcomes, and (3) matching experimental results with the corresponding theoretical probabilities strengthens the meaning of theoretical probability. As Pratt (2000) suggests, meaningful tasks that make use of various manipulatives and generators such as spinners, dice, cards, computer simulations or other items are effective tools for this. In the present study, the goal was to determine what was occurring when the subject of probability was taught via educational games.

Methods

The present study is a case study as our major aim is to attain very detailed views of participants. The most important characteristic of the case study is that it enables us to focus on a special subject, group or situation (Milas & Huberman, 1994; Yin, 1994).

Participants

This study was conducted with 24 fourth graders and their teacher from an elementary school in Turkey. The results of interviews with teachers and school administrators revealed that students were generally from low and middle socioeconomic environments, and it was also understood from students' school reports that the sample is heterogeneous in terms of achievement level. In the meeting held with students prior to the implementation process, all students showed their overeagerness by making requests, such as, "*Teacher, teacher, please, can I play?, Please...*", to take part in the study (See Figure 1a). These students were given code names such as "Student A", "Student B", "Student C"...

Data Collection

Data were collected through the responses of eight selected students (A,G-high; C,J,L-middle; D,H,K-low) with different mathematics ability levels (*from low- to high-level ability based on teachers' opinions and their grades in the reports*) to the semi-structured interviews, teacher's views regarding the process, researchers' evaluations of students' thinkings, students' journal entries (interesting ones) regarding the process and audio and video recordings of students' interactions for three class hours (each 40 minutes). Triangulation of these sources of data enabled us to develop different perspectives and interpretations of students' reflections.

Procedure

The instructions were performed according to the fourth-grade curriculum in Turkey. The curriculum (MEB, 2009) stresses that the subject of probability should be taught in such a way that students will learn the meaning of concepts "*likely*", "*most likely*", "*equal chance*", "*possible*", "*impossible*", "*certain*" and "*uncertain*" and distinguish them. As noted by Andrew (2009), probability concepts must be taught to students at this level by having them engaged in hands-on experiences. For this end, educational games that enable students both to have fun and also to try and experience are considered suitable. Thus, games suitable for 4th graders' levels and suitable for teaching the subject of probability were designed by the researchers. After the students were separated into seven heterogeneous 3- or 4-student groups (*mixed in ability - based on the teacher's views and the grades in their report cards*), these games were played with them. Along the process, the researchers made sure that each student in the groups was engaged in games.



Figure 1. Reflections from the classroom

The Games

Three games, named “Which Spinner?”, “Drawing Ball”, and “Deal or No Deal?”, were designed by the researchers. In these games, as emphasized in the curriculum (MEB, 2009), the aim was to help students gain the basic level of knowledge regarding probability in such a way that the students perceive what the concepts “likely”, “most likely”, “equal chance”, “possible”, “impossible”, “certain” and “uncertain” mean in mathematics. For this reason, arithmetic operations such as addition, subtraction or multiplication were not used, and what the probability of events was, was not asked during instructions. Instead, chance comparisons were focused on heavily. Also, before the initiation of real implementations, some pilot implementations were carried out so as to see the effects of games during implementations and possible problems.



Figure 2. Materials developed and used in games

Data Analysis

Data were grouped and presented as (a) teacher’s views regarding the process, (b) researchers’ evaluations of students’ thinking, (c) audio and video recordings of students’ interactions, (d) the responses of the eight selected students to the semi-structured interviews, (e) students’ journal entries regarding the process. Measures were taken in order to increase the validity and reliability of the study: (1) one of

the researchers took part in the study as participant/observer, (2) participants of the study were clearly defined, (3) social environments and processes during the study were defined, (4) as Yin (1994) suggested, the opinions of participants were presented directly, without commenting, (5) more than one researcher took part in the study, (6) findings gathered through observation and interviews were presented in comparisons.

Findings and Discussion

In this section, we describe findings obtained during and after applying the game-based teaching of probability.

Teacher's Views Regarding the Process

The teacher believed that the games had positive effects, especially on students' motivation and desire to participate in the instructions. And, in response to the question, "What do you think about the process?", he exclaimed, "Wow! *There was a great number of students who participated in the process. Even the ones who have the lowest mathematics ability and never engage in my lessons asked the researcher to be able to participate along the process...*". During the interviews held, it was seen that the teacher was surprised to see students' performance during the process. He was both surprised and happy to see that even students who were quite passive in his class were actively participating. The teacher expressed that adding some fun to the classroom environment was effective in having students like math and participate in class, which they normally refrained from doing. He stated his observations: "*I saw that the students paid more attention to instructions because the games helped them gain the demand of learning mathematics via entertaining environment. So, games should definitely be used as a teaching method to help students overcome math anxiety...*". In parallel, literature on the effects of games stresses that games make students active (Kumar & Lightner, 2007) and provide entertaining learning environments (Ahmad, Shafie, & Latif, 2010; Bayırtepe & Tüzün, 2007; Nisbet & Williams, 2009).

The teacher also stated that this process is effective in helping students understand the subject and that it should definitely be used in teaching math. This finding was inferred from the teacher's statements: "*The games contributed to keeping the concepts in mind, because at the end of instructions, the students could reason correctly about the conceptual questions you asked... Finally, after seeing the whole process, I could say that despite the fact that the games require a lot of time and money to prepare, we have to use this method for effective mathematics teaching.*" It could actually be noted that games designed according to students' levels and the subject to be taught are effective in creating meaningful and permanent learning experiences. The studies of Burguillo (2010), Ke and Grabowski (2007), Kebritchi et al. (2010) and Nisbet and Williams (2009) mentioned similar effects of educational games.

Researchers' Evaluations of Students' Thinking

The researchers' opinions regarding the process are parallel with opinions expressed by the teacher above. In general, both researchers had the view that students enjoyed

the process and had a desire to learn. The researcher managing the process expressed that he was not bored with the class during the whole lesson he taught via games and that students also had fun and were willing to join in the games. However, he also stated that the noise created due to all students wanting to take part in the games and having not previously been exposed to a cooperative learning environment affected the process negatively. Literature also points out that noise in the classroom affects learning and teaching process negatively (Shield & Dockrell, 2003; Yaman, 2006). Therefore, the teacher should be extra careful about managing the process in such environments.

The basic aim in these environments where such approaches are used is to teach subjects meaningfully without creating boredom in class. In this sense, the evaluation made by the researcher is of great importance in terms of effectiveness of these kinds of classes held in these environments. Sfard et al. (1998) point out that the possibility of a productive contribution to mathematical communication by the participants is the first thing to consider and thus, the participants have to (a) be constructive and creative; (b) communicate mathematically in a productive manner; (c) allow for meta-cognitive shifts in such environments. It is believed that applications in the future will be more effective after taking these matters into account.

Audio and Video Recordings of Students' Interactions

Audio and video recordings clearly reveal the teacher and the researchers' opinions. Provision of dialogues between students and the researcher during the teaching process gave clearer information about the teaching and learning environment. Audio and video recordings showed that group members engaged in heated debates among themselves to win the games. It was also observed that lower-level students benefitted more from the process. For example, the following was a dialogue between the members of a group during the "Which Spinner" Game:

Student A (High): *In my opinion, spinner A is more advantageous.*

Student B (Low): *Oh, there is no difference.*

Student C (Middle): *Why no difference?*

Student B: *Because...*

Student A: *Because it has more red coloured sectors.*

Student D (Low): *I did not understand.*

Student A: *When the spinner stops at red, you will win two oranges and if it stops at green, you will win one orange.*

Student D: *Which means?*

Student A: *As there are more red colors in spinner A, it would be more advantageous in terms of winning more oranges.*

Student C: *I agree with you.*

Student B: *Hmmm.*

Student D: *Now, I got it better.*

Student A: *Let's spin and see [They happily shouted 'Yes!'].*

...

This dialogue showed that students benefitted from the process by sharing their ideas with each other. It was observed that students corrected each other's mistakes with the help of their friends and with the help of the researcher. This interaction among students shows the importance of game-based cooperative learning in these environments. A substantial amount of research (Burguillo, 2010; Hamalainen, 2008; Hänze & Berger, 2007; Johnson & Johnson 1989; Slavin, 1987; 1996; Toumasis, 2004; Vasileiadou, 2009) provides evidence of similar effects of cooperative learning. Also, as Sfard et al. (1998) stated, it can be concluded that through argumentation between researcher-student and student-student, the researcher had the opportunity to learn about the student's thinking. One of the most striking points observed in the dialogues is that students wanted to play the games as soon as possible. As Vygotsky (1978) pointed out, students at this age are very interested in games which increases their performance by having them focus more during the games. The literature and dialogues above show how game-based teaching is important for students of this age.

The Responses of Selected Students to the Semi-Structured Interviews

The interview results are presented in the order of the questions "Can you compare this instruction with that which you had before?", "How did this process affect what you learned about the subject of probability?", "What changes, positive or negative, occurred as a result of these instructions?" Some of the students' answers to these questions are presented below in their own words:

Question 1: Can you compare this instruction with that which you had before?

- *... While only some of our successful friends used to participate in instruction in the previous ones, almost all of our friends participated in this one... (Student A, G-High)*
- *... In the previous ones, our teacher used to tell about the subject verbally and we used to write information on paper. Now we enjoyed playing games. We took notes during these lessons from time to time but each student took his/her own notes as what information was important differed from person to person... (Student H-Low)*

Question 2: How did this process affect what you learned about the probability subject?

- *... We had both fun and learned... (All Students-A, C, D, G, H, J, K, L)*
- *... That when we turned the spinners, they mostly stopped at areas with different colours surprised me... I understood that probability has nothing to do with luck. For example, I saw that the amounts of money that were the greatest in number were more likely to come out of the boxes... (Student J-Middle; Student G-High)*

Question 3: What changes, positive or negative, occurred as a result of these instructions?

- *... Even our friends not participating in lessons at regular times participated in the process... (Student A, G-High)*

- ...*The process was more entertaining...* (Generally, all Students- A,C,D,G,H,J,K,L)
- ...*There was too much noise in our classroom due to the fact that most of our friends wanted to play the games...*(Student J,L-Middle; Student G-High)

As can be seen from the excerpts of interviews with students above, teaching carried out with educational games increased students' motivation. Increase in students' motivation levels helped students learn probability better. This finding confirms previous research showing that the use of these kinds of games increases students' motivation levels (Ahmad et al., 2010; Bragg, 2007; Burguillo, 2010; Gros, 2007; Kebritchi et al., 2010; Nisbet & Williams, 2009).

Students' Journal Entries Regarding the Process

Findings similar to those above were obtained from students' journal entries. This data collection source suggested that this process created through the use of educational games provided a fun and encouraging teaching environment and ensured students' active participation. It was, on the other hand, observed that students who were used to using paper and pencil in their regular classes before found these classes taught with games strange. These findings were gathered after careful analysis of students' opinions about the process in the journals entries. In these entries for example, some students stated:

- ...*We felt as if we were in an entertainment program. The teacher was like the presenter of the game show and we were like contestants. After every trial, we looked at our scores on the board and tried to decided what to do together with our friends...* (Student M-Low; Student C, L-Middle)
- ...*The games captured the attention of everybody. Thus, all of us wanted to play. For example, even Student N-Low, who is one of the laziest students and who does not participate in lessons, became very active during these lessons and told me: "I wish our lessons were always like this"...* (Student O-High)
- ...*We had the chance to learn while having fun, but since everybody wanted to take part, there was a lot of noise in class. Because of this noise, we sometimes had difficulty in hearing our teacher and friends. We even saw that our teacher got tired trying to silence the crowd...* (Student P,Q-Low; Student J,L,R -Middle; Student A,G,S-High)

When examining journal entries, findings similar to those before, including those that students had the desire to participate in the process, learned with fun, and although they were surprised in the beginning of the process, they evidently enjoyed this environment. A reason why students expressed their thoughts easily could be due to the fact that keeping journals allowed them to become independent and think independently. Similar positive effects of journals were pointed out by research on journals (Atasoy & Atasoy, 2006; Jurdak & Zein, 1998; Kallman, 1991; Pugalee, 2004; Stonewater, 2002).

General Discussion and Conclusions

Based on the review of all resources of data collection, it was concluded that game-based teaching performed with cooperative learning groups led to improvements in students' motivation, enabled students to work with peers, facilitated understanding, enhanced attendance, helped students to overcome math anxiety and to combine learning and fun. These positive results are consistent with previous research on the effects of games, including those in which games provide a rich learning environment (Hamalainen, 2008), enhance performance (Burguillo, 2010; Ke & Grabowski, 2007; Kebritchi et al., 2010; Nisbet & Williams, 2009) and motivation (Ahmad et al., 2010; Bragg, 2007; Burguillo, 2010; Gros, 2007; Kebritchi et al., 2010; Nisbet & Williams, 2009), make students active (Kumar & Lightner, 2007), enable students to work within groups (Hamalainen, 2008; Ke & Grabowski, 2007) and provide entertaining learning environments (Ahmad et al., 2010; Bayırtepe & Tüzün, 2007; Nisbet & Williams, 2009).

Negative attitude and anxiety toward mathematics are the two main subjects studied by mathematics education researchers. If these occur in the early years, they become more difficult to overcome in later years. However, from the findings of the current study, it can be said that using game-based teaching performed with cooperative learning groups can be an effective strategy to overcome these problems encountered, especially in subjects such as probability towards which students have negative attitudes (Bulut, 2001). To support this, a number of studies (Bryant, 1981; Emley, 1986; Johnson & Johnson, 1991; Nisbet & Williams, 2009; Oishi, 1983; Tarim & Akdeniz, 2008) indicated that such learning environments provided an opportunity of developing positive attitudes toward mathematics.

Noise during the process, much more time needed to prepare the process, and deviating from the teaching aspect of the interventions by being engrossed in the games can be considered disadvantages of this process. To minimize these disadvantages, the teacher executing the process should know the students and be well experienced in classroom management. Inferring from the findings, it could be stated that despite its drawbacks, well-organized, game-based teaching could lead to significant positive results in terms of students' math learning.

From this point of view, it is thought to be effective to use productive argumentation strategies in teaching probability concepts especially when they are not being taught as effectively in Turkey as they are in many other countries. The reason for this may be due to the common teacher-centered classroom environments, lack of appropriate instructional materials (Gürbüz, 2006; Pijls et al., 2007), students' difficulty in probabilistic reasoning (Fischbein & Schnarch, 1997; Munisamy & Doraisamy, 1998; Polaki, 2002), students' incorrect relations or links between their daily life knowledge and scientific knowledge (Gürbüz, 2006; Gürbüz et al., 2010; Gürbüz, Birgin, & Çatlıoğlu, 2012), and students' negative attitudes towards the subject and low level of achievement in probability (Bulut, 2001). Therefore, game-based teaching, which requires argumentation, reduces academic learning and provides learning relevant to

real life, should be performed in topics such as the subject of probability for which both teaching and learning is a challenge. Furthermore, games can be transferred to a computer environment and the effects of such games could be researched.

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Prikazi procesa poučavanja vjerojatnosti posredstvom igre

Sažetak

Cilj istraživanja bio je odrediti što će se dogoditi kada vjerojatnost poučavamo posredstvom obrazovne igre. Sudionici istraživanja bili su učenici četvrtog razreda (N= 24, dob 9-10) koji su imali tri nastavna sata (u trajanju od 40 minuta) i njihov učitelj. Odabrane igre provodile su se u skupinama od 3 do 4 učenika. Podaci su dobiveni na temelju odgovora osam učenika u polustrukturiranom intervjuu, stavova učitelja o procesu, istraživačke procjene učeničkih razmatranja, učeničkih bilješki u dnevnicima vezanim uz proces, kao i na temelju audio i video zapisa interakcije učenika. Nalazi su prikazani prema načinu prikupljanja podataka. Dokazi ukazuju na to da učenje posredstvom igre potiče razumijevanje, poboljšava sudjelovanje učenika i motivaciju, omogućuje zajednički rad s djecom, pomaže u suzbijanju straha od matematike, stvara zabavno okruženje za učenje, ali kao posljedicu ima poroblem vladanja razredom i prilično bučnu atmosferu za učenje.

Ključne riječi: suradničko učenje; učenje posredstvom igre; matematika; stavovi učitelja i učenika; vjerojatnost.

Uvod

Igre su oduvijek imale važnu ulogu u nastavi matematike jer potiču logičko-matematičko razmišljanje (Kamii i Rummelsburg, 2008), doprinose razvoju znanja i istodobno imaju pozitivan utjecaj na afektivnu ili emocionalnu komponentu učenja (Booker, 2000), mogu utjecati na povećanje interesa učenika i na motivaciju (Bragg, 2007), omogućuju jedinstvenu priliku za integraciju kognitivnih, afektivnih i socijalnih aspekata učenja (Pulos i Sneider, 1994; Rieber, 1996), mogu poboljšati znanje o brojevima kod male djece (Kumar i Lightner, 2007). Štoviše, može se jasno tvrditi da, posebno posredstvom obrazovnih igara, učenici imaju mogućnost učiti u elastičnom okruženju u suradnji s ostalim učenicima i tako učiti aktivno. Literatura nam govori da je jedan od najvažnijih čimbenika koji doprinosi učinkovitom učenju posredstvom igre argumentacija ili dokazivanje (Sfard i sur., 1998; Yackel, 2002). Argumentacija pomaže učenicima da uče zajednički, pomaže u lakšem izražavanju ideja, objašnjavanju i opravdanju vlastitog promišljanja, kao i razvoju matematičkog jezika.

Suradničko učenje u malim skupinama

Prijašnja istraživanja ukazivala su na korisnost suradničkog učenja uključujući motivaciju učenika na učenje matematike na način da im se prikažu načini na koje mogu uživati u matematici (Johnson i Johnson, 1989), pomažući im kako bi se usredotočili na predmet ili zadatak i kako bi im se osiguralo zajedničko učenje u ugodnom okruženju (Slavin, 1996), omogućujući učenicima da učinkovitije komuniciraju s drugim članovima skupine (Martino i Johnson, 1979). Slično tome, velik broj drugih istraživanja (Burguillo, 2010; Hamalainen, 2008; Hänze i Berger, 2007; Toumasis, 2004; Vasileiadou, 2009) podržao je uvođenje suradničkog učenja s ciljem učinkovitog poučavanja. Pokazuje se da organiziranje učenika u suradničke skupine učenicima više pomaže u procesu učenja. Davanje uputa u takvim okruženjima, kada učenici jedni s drugima argumentirano razgovaraju o matematici, moglo bi postati osnova poučavanja matematike (Sfard i sur., 1998). Stoga se može reći da argumentacije učenika imaju veliku ulogu u pojavnosti takvih pozitivnih učinaka posredstvom suradničkog učenja.

Zašto učenje posredstvom igre?

U Turskoj su učenici podvrgnuti formalnom učenju vjerojatnosti u četvrtom razredu (u dobi između 9 i 10 godina). Nedavna istraživanja pokazala su da djeca u toj dobi mogu identificirati manje i više vjerojatne ishode (Nikiforidou i Pange, 2010; Way, 2003) i razlikovati «sigurne» od «nemogućih» i «mogućih» događaja (Jones i sur., 1997). Andrew (2009) tvrdi da se koncepti u vjerojatnosti mogu bolje razumjeti ako se učenici najprije izlože vjerojatnosti putem eksperimenata. Prema Andrew, (1) provođenje eksperimenata pomaže učenicima da razlikuju elemente u uzorku i specifične ishode prema interesu, tj. ishod «uspjeha», (2) provođenje eksperimenta veći broj puta može pokazati učenicima vjerojatnost određenih vrsta ishoda i (3) usklađivanje rezultata eksperimenta s odgovarajućim teorijskim vjerojatnostima učvršćuje značenje teorijske vjerojatnosti. Kao što Pratt (2000) predlaže, kola sreće (*eng.* spinners), kocke, karte, računalna simulacija i drugi predmeti vrlo su učinkovit alat poučavanja. U ovome je istraživanju cilj bio ustanoviti što se događalo kada je predmet vjerojatnosti poučavan posredstvom obrazovnih igara.

Metode

Koristili smo se metodom istraživanja slučaja s obzirom na to da nam je glavni cilj dobiti vrlo detaljna opažanja sudionika. Najvažnija karakteristika istraživanja slučaja jest da omogućuje istraživaču da se usredotoči na specifičan predmet, skupinu ili situaciju (Milas i Huberman, 1994; Yin, 1994).

Uzorak

Istraživanje je provedeno nad 24 učenika četvrtog razreda i njihovim učiteljem u osnovnoj školi u Turskoj. Rezultati intervju s nastavnicima i upravom škole otkrili su

da učenici uglavnom dolaze is nižeg ili srednjeg društveno-materijalnog okruženja, pa se iz njihovih školskih svjedodžbi može zaključiti da je uzorak heterogen s obzirom na školski uspjeh. Na sastanku koji je održan s učenicima prije istraživanja svi su učenici pokazali čak pretjeranu zainteresiranost za sudjelovanjem u istraživanju (vidi Sliku 1-a) postavljajući pitanja poput: "Učitelju, učitelju, mogu li molim Vas ja igrati", Molim Vas..." Učenici su dobili oznake: "Učenik A", "Učenik B", "Učenik C"...

Prikupljanje podataka

Prikupljene podatke činili su odgovori koje je dalo osam odabranih učenika (A, G - visoki; C, J, L - srednji; D, H, K - niski) različitih matematičkih sposobnosti (*od niske do visoke razine sposobnosti prema učiteljevu mišljenju i ocjenama u svjedodžbama*) u polustrukturiranom intervjuu, učiteljevi pogledi vezani uz proces, dojmovi istraživača o učeničkim odgovorima, učenički dnevници (oni zanimljiviji) vezani uz proces, kao i audio i video snimke učeničkih interakcija tijekom tri nastavna sata (svaka u trajanju od 40 min.) Triangulacijom tih izvora podataka omogućen nam je razvoj različitih perspektiva i interpretacija učeničkih dojmova.

Postupak

Upute su davane u skladu s turskim kurikulumom za četvrti razred. Kurikul (MEB, 2009) naglašava da bi se predmet vjerojatnosti trebao poučavati na način na koji će učenici naučiti značenje termina "vjerojatno", "vrlo vjerojatno", "jednakih mogućnosti", "moguće", "nemoguće", "sigurno" i "nesigurno" i moći ih razlikovati. Prema Andrew (2009), pojmovi vjerojatnosti moraju se na toj razini poučavati putem primjenjivih načina učenja. U ovome slučaju obrazovne igre koje učenicima omogućuju učenje putem zabave i iskustva smatraju se prikladnima. Igre koje su primjerene razini četvrtog razreda i učenju vjerojatnosti osmislili su sami istraživači. Nakon što su učenici razdvojeni u sedam heterogenih skupina od po 3-4 učenika (*prema sposobnostima – na osnovi učiteljeve procjene i ocjena u svjedodžbama*), primijenili smo igre. Za vrijeme trajanja eksperimenta, istraživači su se pobrinuli za to da svaki učenik bude uključen u igre.

Slika 1.

Igre

Tri igre naslovljene "Kolo sreće?", "Povlačenje lopte" i "Pogodba ili povlačenje?" osmislili su istraživači. U tim igrama, kao što naglašava kurikulum (MEB, 2009), cilj je pomoći učenicima da razumiju što pojmovi: "vjerojatno", "vrlo vjerojatno", "jednakih mogućnosti", "moguće", "nemoguće", "sigurno" i "nesigurno" znače u matematici. Zbog toga se aritmetičke operacije poput zbrajanja, oduzimanja ili množenja nisu koristile, a za vrijeme davanja uputa nisu se tražile vjerojatnosti u događanjima. Umjesto toga, naglasak je bio isključivo na slučajnim usporedbama. Također, prije uspostave eksperimenta proveden je pilot-projekt kako bi se uvidjele posljedice igara za vrijeme provedbe eksperimenta, kao i mogući problem.

Slika 2.

Analiza podataka

Podaci su grupirani i prikazani kao (a) učiteljevo gledište procesa, (b) procjena istraživača o mišljenjima učenika, (c) audio i video snimke učeničkih interakcija, (d) odgovori osam odabranih učenika u polustrukturiranom razgovoru, (e) učenički dnevnicima vezani uz proces. Mjere su provedene kako bi se povećala valjanost i pouzdanost istraživanja: (1) jedan od istraživača sudjelovao je u istraživanju u funkciji sudionik/promatrač, (2) sudionici u istraživanju jasno su definirani, (3) društvena okruženja i procesi istraživanja jasno su definirani, (4) kao što (1994) predlaže, mišljenja sudionika izravno su prikazana bez komentara, (5) u istraživanju je sudjelovalo više istraživača, (6) rezultati promatranja i intervju prikazani su usporedno.

Rezultati i rasprava

Ovdje će biti opisani rezultati do kojih se došlo za vrijeme i nakon primjene poučavanja vjerojatnosti posredstvom igre.

Učiteljevi pogledi na proces

Učitelj je vjerovao da igre imaju pozitivan učinak, posebno na motivaciju učenika i želju za sudjelovanjem u davanju uputa. U odgovoru na pitanje: "Što mislite o procesu?", učitelj je uzviknuo: "Wow!" *Velik broj učenika sudjelovao je u nastavnom satu. Čak i oni koji imaju najniže matematičke sposobnosti i nikada ne sudjeluju u mojim satima pitali su istraživača mogu li sudjelovati u procesu...*. Za vrijeme intervju bilo je vidljivo da je učitelj iznenađen izvedbom učenika za vrijeme istraživanja. Bio je iznenađen i sretan što vidi da su čak i učenici koji su bili prilično pasivni za vrijeme njegovih sati aktivno sudjelovali. Učitelj je izjavio da unošenje zabave u nastavni sat ima takav učinak na učenike da zavole matematiku i sudjeluju u radu na satu, što obično nije slučaj. Svoje mišljenje izrekao je na sljedeći način: "Vidio sam da učenici pridaju veću pozornost uputama jer su im igre omogućile svladavanje matematike putem zabavnog okruženja. Dakle, igre bi definitivno trebale biti iskorištene kao metoda poučavanja kako bi učenici prevladali strah od matematike...". U skladu s tim, literatura o učincima igara naglašava da igre čine učenike aktivnijima (Kumar i Lightner, 2007) i stvaraju zabavno okruženje za učenje (Ahmad, Shafie & Latif, 2010; Bayırtepe i Tüzün, 2007; Nisbet i Williams, 2009).

Učitelj je također izjavio da je proces učinkovit s obzirom na to da pomaže učenicima da razumiju predmet te da bi ga definitivno trebao iskoristiti u poučavanju matematike. To je zaključeno na temelju sljedeće izjave učitelja: "Igre su doprinijele zadržavanju koncepta u glavi, jer su na kraju davanja uputa učenici mogli točno prosuđivati kod pitanja koja su vezana uz koncepte... Na kraju, nakon što sam vidio cijeli proces, mogu reći da, unatoč tome što igre zahtijevaju puno vremena i novca za pripremu, moramo ih iskoristiti kako bi poučavanje matematike bilo učinkovitije." Zapravo, moglo bi se reći da

se igre koje su namijenjene razinama učeničkih mogućnosti i predmetima smatraju učinkovitima prilikom stvaranja suvislih i postojanih iskustava učenja. Istraživanja koja su proveli Burguillo (2010), Ke i Grabowski (2007), Kebritchi i sur. (2010), Nisbet i Williams (2009) spominju slične učinke nekih obrazovnih igara.

Procjene mišljenja učenika

Mišljenja istraživača o procesu podudaraju se s mišljenjima učitelja. Oba istraživača misle da su učenici uživali u procesu i da su pokazali volju za učenjem. Istraživač koji je vodio proces izjavio je da mu nije bilo dosadno u razredu za vrijeme trajanja sata u kojem je poučavao posredstvom igre i da su se učenici također zabavili i pokazali inicijativu da se uključe u igre. Međutim, također je izjavio da je razina buke koju su stvorili učenici koji su željeli sudjelovati u igri i činjenica da ti učenici do sada nisu sudjelovali u suradničkom učenju negativno utjecala na proces. Literatura govori o tome da buka u razredu utječe na učenje i poučavanje na negativan način (Shield i Dockrell, 2003; Yaman, 2006). Prema tome, učitelj mora biti vrlo oprezan kod upravljanja procesom u takvim okruženjima.

Glavni cilj okruženja u kojima se javljaju takvi pristupi jest poučavati predmet svrhovito, bez stvaranja dosade u razredu. U tom pogledu evaluacija koju je ponudio istraživač vrlo je važna s obzirom na učinkovitost nastavnih sati koji se održavaju u takvim okruženjima. Sfarid i sur. (1998) ukazuju na to da je mogućnost pozitivnog doprinosa matematičkoj komunikaciji među sudionicima prvo što moraju uzeti u obzir i shodno tome sudionici moraju (a) biti konstruktivni i kreativni, (b) komunicirati matematički na produktivan način, (c) dopustiti meta-kognitivne pomake u takvim okruženjima. Vjeruje se da će takve primjene u budućnosti biti puno učinkovitije ako se navedeno uzme u obzir.

Audio i video zapisi interakcije učenika

Audio i video zapisi jasno otkrivaju mišljenja nastavnika i istraživača. Omogućavanje dijaloga između učenika i istraživača u vrijeme istraživanja daje jasnu informaciju o poučavanju i okruženju za učenje. Audio i video zapisi pokazali su da su se članovi skupina uključivali u žustre rasprave među sobom kako bi pobijedili u igrama. Također je vidljivo da su učenici nižih sposobnosti imali više koristi od procesa. Primjerice, slijedi dijalog među članovima skupina koji se odigrao za vrijeme trajanja igre "Kolo sreće":

Učenik A (visoki): *Moje je mišljenje da je kolo sreće A u prednosti.*

Učenik B (niski): *Oh, nema razlike.*

Učenik C (srednji): *Zašto nema razlike?*

Učenik B: *Zato...*

Učenik A: *Zato što ima više crvenih područja.*

Učenik D (niski): *Ne razumijem.*

Učenik A: *Kada se kolo sreće zaustavi na crvenom polju, dobit ćeš dva narančasta, a ako se zaustavi na zelenom, dobit ćeš jedno narančasto.*

Učenik D: Što to znači?

Učenik A: S obzirom na to da ima više crvenih boja u kolu sreće A, on će biti u prednosti kod osvajanja više narančastih.

Učenik C: Slažem se s tobom.

Učenik B: Hmm.

Učenik D: Sada to bolje razumijem.

Učenik A: Hajdemo zavrtjeti i vidjeti [Uzbuđeno su poviknuli: 'Da!'].

...

Takvi dijalozi pokazuju da su učenici imali koristi od procesa jer su razmjenjivali ideje. Uočeno je da su učenici međusobno ispravljali pogreške uz pomoć prijatelja i istraživača. Takva interakcija među učenicima ukazuje na važnost suradničkog učenja posredstvom igre u takvim okruženjima. Znatno broj istraživanja (Burguillo, 2010; Hamalainen, 2008; Hänze i Berger, 2007; Johnson i Johnson 1989; Slavin, 1987; 1996; Toumasis, 2004; Vasileiadou, 2009) daje dokaze o sličnim učincima suradničkog učenja. Također, Sfard i sur. (1998) tvrde da se može zaključiti da putem rasprave istraživač-učenik i učenik-učenik istraživač ima priliku učiti o načinu na koji učenik razmišlja. Jedna od bitnih točki koje su uočene u dijalogima jest da su učenici htjeli što prije početi s igrama. Kao što tvrdi Vygotsky (1978), učenici su u toj dobi jako zainteresirani za igre, na njih se više usredotočuju i to povećava njihovo djelovanje. Literatura i prikazani dijalozi pokazuju da je učenje posredstvom igre bitno za učenike te dobi.

Odgovori odabranih učenika u polustrukturiranom intervjuu

Rezultati intervjuja prikazani su prema redu pitanja: "Možeš li usporediti ovo poučavanje s onim prijašnjim?", "Kako je ovaj proces utjecao na ono što si naučio o predmetu vjerojatnosti?", "Koje su se promjene, pozitivne ili negativne, dogodile kao rezultat ovakvog poučavanja?" Evo nekih učeničkih odgovora na ta pitanja:

Pitanje 1: Možeš li usporediti ovo poučavanje s onim prijašnjim?

- ...Dok su prije samo neki uspješni prijatelji sudjelovali u nastavi, sada su gotovo svi naši prijatelji sudjelovali u nastavi... (Učenik A, G – visoko)
- ...U prijašnjoj nastavi učitelj nam je govorio o predmetu verbalno i mi bismo to zapisivali na papir. Sada smo uživali igrajući igre. Za vrijeme tih sati povremeno smo radili bilješke, ali svaki je učenik zapisivao svoje bilješke, pa su bilješke o onome što je bitno bile različite od učenika do učenika ... (Učenik H – nisko)

Pitanje 2: Kako je ovaj proces utjecao na ono što si naučio o predmetu vjerojatnosti?

- ...Bilo nam je zabavno i naučili smo nešto ... (svi učenici – A,C,D,G,H,J,K,L)
- ...Kada okrenemo kolo sreće, uglavnom su se zaustavljali na područja s različitim bojama i to me je iznenadilo.... Shvatio sam da vjerojatnost nema veze sa srećom.

Na primjer, vidio sam da je količina novca koja je bila najveća, brojčano češće izlazila iz kutija... (Učenik J – srednje; Student G – visoko)

Pitanje 3: Koje su se promjene, pozitivne ili negativne dogodile kao rezultat ovakvog poučavanja?

- ... Čak su i naši prijatelji koji inače nisu sudjelovali u nastavi, sudjelovali u ovome procesu... (Učenik A, G – visoko)
- ...Proces je bio više zabavan... (Uglavnom svi učenici – A, C, D, G, H, J, K, L)
- ...Bilo je previše buke u našem razredu s obzirom na činjenicu da je većina naših prijatelja htjela igrati igre ... (Učenik J, L – srednje; Učenik G – visoko)

Kao što se vidi iz izvadaka iz intervjua s učenicima, poučavanje putem obrazovnih igara povećalo je motivaciju učenika. Povećanje motivacije učenika omogućilo im je da bolje svladaju predmet vjerojatnosti. Takav je rezultat u skladu s prijašnjim rezultatima istraživanja koji pokazuju da igre povećavaju razinu učeničke motivacije (Ahmad i sur., 2010; Bragg, 2007; Burguillo, 2010; Gros, 2007; Kebritchi i sur., 2010; Nisbet i Williams, 2009).

Učenički dnevnik vezani uz proces

Rezultati slični navedenima dobiveni su i iz učeničkih dnevnika. Izvor podataka pokazao nam je da je proces poučavanja putem obrazovne igre omogućio zabavno i motivirajuće okruženje i da je osigurao aktivno sudjelovanje učenika. S druge strane, učenicima koji su naučeni na pisanje u prijašnjoj nastavi takve su igre bile pomalo strane. Rezultati su prikupljeni nakon pomne analize učeničkih mišljenja o procesu, što su zapisivali u svojim dnevnicima. U nekim dnevnicima piše:

- ...Osjećali smo se kao da smo u zabavnom programu. Učitelj je bio voditelj programa, a mi smo bili poput natjecatelja. Nakon svakog pokušaja, pogledali bismo rezultate na ploči i pokušali odrediti što bismo mogli učiniti zajedno s našim prijateljima ... (Učenik M – nisko; Učenik C, L – srednje)
- ...Igre su zaokupile pažnju svih. I tako smo svi htjeli igrati. Na primjer, čak je i Učenik N – nisko, koji je jedan od najmlađih učenika i koji nikada ne sudjeluje, bio vrlo aktivan za vrijeme tih sati i rekao mi je: „Kada bi barem sati uvijek bili ovakvi“... (Učenik O – srednje)
- ... Imali smo priliku učiti dok smo se zabavljali, ali s obzirom na to da je svako htio sudjelovati, bilo je puno buke u razredu. Zbog buke smo ponekad teško čuli našeg nastavnika ili prijatelje. Čak smo vidjeli da je i učitelj postao umoran od pokušaja smirivanja buke... (Učenik P, Q – nisko; Učenik J, L, R – srednje; Učenik A, G, S – visoko).

Nakon proučavanja učeničkih dnevnika, pokazalo se da su rezultati slični ostalima, odnosno da su učenici iskazali želju za sudjelovanjem u procesu, da su učili na zabavan način i iako su na početku bili iznenađeni, njihovo uživanje za vrijeme trajanja istraživanja bilo je očito. Razlog zbog kojega su učenici izrazili svoja razmišljanja bez

napora moguće je naći u činjenici da je vođenje dnevnika omogućilo samostalno razmišljanje. Slični, pozitivni učinci vođenja dnevnika, očitovali su se i u istraživanjima o dnevnicima (Atasoy i Atasoy, 2006; Jurdak i Zein, 1998; Kallman, 1991; Pugalee, 2004; Stonewater, 2002).

Rasprava i zaključci

Na osnovi proučavanja svih izvora podataka zaključeno je da poučavanje putem igre u suradničkim skupinama dovodi do poboljšanja u motivaciji učenika, omogućuje učenicima rad s vršnjacima, olakšava razumijevanje, promiče prisutnost, pomaže učenicima da prevladaju strah od matematike i spaja učenje i zabavu. Ti pozitivni rezultati u skladu su s prijašnjim istraživanjima učinaka igre, uključujući i one u kojima igre stvaraju bogato okruženje za učenje (Hamalainen, 2008), potiču djelovanje (Burguillo, 2010; Ke i Grabowski, 2007; Kebritchi i sur., 2010; Nisbet i Williams, 2009) i motivaciju (Ahmad i sur., 2010; Bragg, 2007; Burguillo, 2010; Gros, 2007; Kebritchi i sur., 2010; Nisbet i Williams, 2009), aktiviraju učenike (Kumar i Lightner, 2007), omogućuju učenicima rad u skupinama (Hamalainen, 2008; Ke i Grabowski, 2007) i osiguravaju zabavno okruženje za učenje (Ahmad i sur., 2010; Bayırtepe i Tüzün, 2007; Nisbet i Williams, 2009).

Negativan stav prema matematici i strah od matematike dva su glavna problema koja proučavaju istraživači u području nastave matematike. Ako se ta dva problema pojave u ranom periodu učenja, teže ih je riješiti u sljedećem razdoblju. Međutim, rezultati ovoga istraživanja pokazuju da igre u nastavi, zajedno sa suradničkim učenjem, mogu biti učinkovita strategija za prevladavanje tih problema, posebno kod poučavanja vjerojatnosti prema kojoj učenici imaju negativne stavove (Bulut, 2001). Kako bi to podržali, autori (Bryant, 1981; Emley, 1986; Johnson i Johnson, 1991; Nisbet i Williams, 2009; Oishi, 1983; Tarim i Akdeniz, 2008) su utvrdili da takva okruženja za učenje omogućuju učenicima stvaranje pozitivnih stavova prema matematici. Buka za vrijeme nastave, vrijeme koje je potrebno za pripremu nastave, odudaranje od aspekta poučavanja s obzirom na intervencije koje nastaju kada igra obuzme učenike mogu se smatrati nedostacima takve nastave. Kako bi se ti nedostaci umanjili, nastavnik koji poučava trebao bi poznavati učenike i biti sposoban upravljati razredom. Iz rezultata bismo mogli utvrditi da unatoč nedostacima dobro-organizirana nastava utemeljena na igri mogla bi osigurati važne, pozitivne rezultate u učenju matematike.

S tog se gledišta smatra učinkovitim koristiti se produktivnim strategijama dokazivanja, posebno kod poučavanja pojma vjerojatnosti, i posebno s obzirom da se ne poučavaju jednako učinkovito u Turskoj kao u mnogim drugim zemljama. Mogući je razlog za to okruženje u kojem nastavnik dominira, nedostatak valjanih materijala za poučavanje (Gürbüz, 2006; Pijls i sur., 2007), poteškoće učenika kod zaključivanja o vjerojatnosti (Fischbein i Schnarch, 1997; Munisamy i Doraisamy, 1998; Polaki, 2002), nevaljale veze ili poveznice učenika sa svakodnevnim znanjem o životu i poznavanjem znanosti (Gürbüz, 2006; Gürbüz i sur., 2010, Gürbüz, Birgin

i Çatlıoğlu, 2012) i negativni stavovi učenika prema predmetu, kao i niska razina postignuća u predmetu vjerojatnosti (Bulut, 2001). Prema tome, učenje posredstvom igre, koje zahtijeva argumentiranje, omogućuje učenje koje je relevantno za svijet koji nas okružuje i moralo bi se primijeniti na teme poput vjerojatnosti, iako je to izazov i za poučavanje i za učenje. Nadalje, igre se mogu prenijeti i na računalno okruženje, a učinci takvih igara mogli bi se dodatno istražiti.