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MAKING AN EDUCATIONAL GAME TO TEACH PRIMARY SCHOOL STUDENTS THE MEANING OF NATURAL NUMBERS

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Abstract:
Teaching mathematical concepts contains many contents such as: specific characteristics, properties, and exercises. Among them, teaching the meaning of concepts also plays an important role. The meanings of concepts are associated with the history of concepts and enable us to know the nature of concepts deeply. There are many teaching methods or ways to teach the meanings of concepts such as: designing exercises, creating situations, holding an experimental research. Here, our choice is an educational game because in teaching mathematics, it is regarded as a pleasant, amusing learning form, based on the created situation to help pupils apprehend the new knowledge, consolidate the old knowledge, skills, solution methods, the experience of life self-consciously, actively, independently and creatively. This paper offers an educational game to teach the meaning of natural numbers. The results show that students have recognized the meaning of natural numbers in the last phase of the game due to the teacher's help.

Keywords: educational game, mathematical concepts, the meaning of concepts, natural numbers

1. Introduction

1.1 Some benefits of educational games

Bragg (2003) has suggested that game is a good way of motivating students, then developing their positive attitudes and raising their success in problem solving. In his study, 210 students played games of solving problems related to decimal numbers. Some research findings are drawn that most students are motivated and feel success in

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their mathematics lessons. In addition, many children have a positive attitude towards mathematics and learning. Meanwhile, in his Likert scale survey, it appeared that game negatively affected attitudes. (Bragg, 2007).

Erika (2012) pointed out the benefits of integrating games into mathematics teaching and learning. First, the games bring meaningful situations, in which mathematical skills are formed. Next, children have more motivation because they are free to choose the games and enjoy playing, then they have positive attitudes towards their learning. Additionally, their thinking abilities are developed through different levels of the games. Also, through the games, teachers have the opportunity to evaluate students' knowledge and mathematical skills. Because of these advantages, she integrated games into her mathematical teaching practice. Besides these benefits, Griffiths (2002) stated that videogames are considered as educational research tools, and develope some basic skills such as: language skills, mathematics and reading skills, and social skills. Moreover, videogames are said to improve children's health care because some games are designed to improve self-care skills and medical compliance in children.

Kaune et al. (2013) said that games play an important role in learning and understanding of mathematics. Indeed, learning through the games forms interactions between students because they can work in pairs or in groups when playing. Moreover, one of games' aims is to construct mental models for mathematical concepts and methods. Like other games, mathematics games facilitate individual cognitive and metacognitive skills of learners and motivate them to apply and deepen their knowledge, then improve their attitudes towards mathematics positively due to more engagement in learning mathematics when playing games. From here, the researchers designed some games to enhance metacognitive and discursive activities in mathematics classes. The research findings show that the activities of playing games improve the mathematical performance of students.

Robertson (2012) thought the games are educationally beneficial, so teachers are advised to aware of the advantages of game making because of their motivational power. According to him, game design is a complex task because teachers need to pay attention to many factors such as problem finding, problem solving, evaluation and communication. Furthermore, he pointed out the gender difference in game playing habits and preferences. In his study, girls have games score higher than boys; in particular, they are good at skills associated with storytelling.

1.2 Natural numbers in Vietnamese textbooks

In mathematical history, the natural numbers appeared to be associated with many different meanings. One of the meanings is to indicate the class of equivalent sets. More specifically, the natural numbers that appear should be simultaneously related to the following two mathematical problems:

Kind 1: Identifying the natural number corresponding to the number of elements of the given set.

Kind 2: Creating a set whose number of elements equals the given natural number.

In the textbooks, the above meaning does not exist because exercises usually contain the two problems separately. To give students access to this meaning of natural numbers, teachers can design different teaching situations.

2. Research objectives

From the above notes, the research question is proposed as follows:

Q: Do students succeed in solving situations that have the simultaneous effect of two mathematical problems?

Also, if they succeed in such situations, implicitly, they understand a meaning of natural numbers, ie "*denote the class of equivalent sets*".

3. Research Methodology

3.1 Participants

The participants included 20 students in grade 1 in Le Quy Don primary school in Can Tho city. They learned about natural numbers from 0 to 100.

3.2 Instrument and procedure

The game "Occupying enemy posts" was deployed. This game could be described as follows: "*There are* k *sandboxes, indicated by* k *enemy posts and placed on one side of the classroom in a straight line order. In the opposite corner of the classroom, there is a box containing 40 yellow starred red flags (with flag stickers). Students have the duty to arrive at the same time (once and only) a number of flags from the box, and then plug in each post a flag, so that every enemy post also has a flag attached and no redundant flags*".

Game rules: the teacher informs the whole class:

These are the sandboxes; each box is an enemy post. The other corner has the yellow starred red flags. You will go to occupy enemy posts by taking flags to the posts. An enemy post is called to be occupied if you have one and only one flag in it.

Your task is to pick up some flags and run to the posts. You can only pick up the flag once. The winner is the one who has each post plugged by a flag and has no redundant flags.

The experiment consisted of four phases and was conducted within 90 minutes:

Phase 1: (The teacher informs the game - 5 minutes).

The teacher explains the rules of the game, then call any student to play "try" but he does not play to the end (only play once). The teacher and other students control the rules.

Purpose: Phase 1 aims to help students better understand the rules of the game. In addition, students' activity does not necessarily help students find a way to win. Students' playing is conducted under the control of the referee team. The teacher is just a "hidden" referee.

Phase 2: (students play individually- 60 minutes). During this phase, the fixed number of enemy posts is 21.

The class is divided into two teams. Each team has 10 children participating in the game. Each member of the team is allowed to play 3 times. After the first playing turn, they have to carry the flags back to the old position to play the next turn. At each turn, each team sends a student to compete with the other team's student.

While a student plays, the rest of the students are not observed. When one pair is in the playroom, other students must stand outside of the classroom to observe the pair playing. Students finishing playing come to another room and do not contact with people who have not played.

A group of 3 students is a referee who observes without interference.

Purpose: The highlight in this phase is not to give the discussion of the students to find different ways of playing. We have given students a chance to play as soon as the teacher explains the game and the teacher plays. As a team, they play in the team, but in fact, they play individually. The purpose of such an action is to show the student's personal relationship to the type of assignment assigned.

Phase 3: (Team playing - 15 minutes)

The teacher organizes two teams competing in three rounds. In conjunction with each round, the teacher randomly chooses one pair of students to play. Each student belongs to a different team. Students can discuss the team before playing. They play at 3 times and a number of enemy posts are changed as follows:

Table 1: A number of enemy posts in three rounds

Rounds	A number of enemy posts
1	20
2	24
3	35

Purpose: Phase 3 is the team stage. In phase 2, players are not allowed to discuss, but players in phase 3 have the right to discuss the team before the match. Discussion before the competition also facilitates the optimal strategy to appear. However, it also reveals a more personal student relationship with the situation. Maybe during the discussion, the team offers different ways of playing, but these ways do not work well, students have to think of a different way of playing or reuse the way in the second phase that they see the effect. Our desire is that after 3 rounds they can find out how to always win without the luck of the game. In addition, we would like to see the emergence and evolution of the meaning: "*denote the class of equivalent sets*".

Phase 4: (Validating - 10 minutes)

The class is still divided into two teams. The teacher asks students to state how to help them win. Each statement of this team put out the other team to comment right or wrong. Any statement made by the students is correct; the teacher shall write it on the board.

Purpose: Phase 4 is linked to the debate between the two teams and the review of the teacher. The teacher evaluates and summarizes the strategies the students have used. Then, let the student see the meaning of the natural number: "*denote the class of equivalent sets*".

Table 2: The possible solution strategies for the game

S1	“Random" strategy (basic strategy) Students randomly pick up a number of flags with the number of enemy posts. Success is just luck.
S2	Strategy "Estimate" After observing and estimating the number of enemy posts, the next job is to estimate the number of flags. Then, if the students see the number of "more" then take "many". Conversely, if the students see the number of "less" then pick up the number of "little" flags. Such action is also not effective.
S3	Strategy “count the number of enemy posts without counting flags". Carry out the work of pairing by counting the number of enemy posts and taking the number of arbitrary flags brought together with the number of enemy posts . However, this count also does not create much chance of success.
S4	Strategy "corresponding 1-1" (optimal strategy). - Count the number of enemy posts. - Get the number of flags equal to the number of enemy posts.

	- Pair a flag with an enemy post.
S5	The strategy of "counting additional" If at the first time, the number of flags removed (missing), the next time students will take less (more).

4. Results and discussion

Table 3: Statistics of students' strategies in Phase 2

	Strategy **S1**	Strategy **S2**	Strategy **S3**	Strategy **S4**	Strategy **S5**
Numbers	35 (Succeed: 4)	15 (Succeed: 1)	4 (Succeed: 0)	5 (Succeed: 5)	1 (Succeed: 1)
Percentages	58.33%	25%	6.67%	8.33%	1.67%

From statistics showed that a number of playing turns of the students were implemented using the strategy S1 (35 times, accounting for 58.33%). Most of the times they played randomly picked up the number of flags in order to put on the enemy posts. For example, HB7 all three times randomly took the number of flags in turn: 16 flags, 20 flags, 23 flags. The number of flags changed, in turn showed that the child adjusted the number of flags needed. But all three failed. There were many children who took very small numbers of flags such as HA1, HB1, HA6 only got the number 7, 9, 8 respectively. This showed that they did not care much about the number of enemy posts. Of the 35 randomly selected children, only four were successful. Here, the probability of success when using S1 was very low (only 0.11).

Of the 60 turns played by the students, there were 15 turns under the S2 strategy of 25%. This percentage was also quite high compared to the number of turns per strategies S3 and S4. Among them, there was only the successful third turn of HB8. After two unsuccessful attempts, she switched to an accurate estimate of her number. The probability of success of S2 was very low, in this case only 0.067.

There were 4 playing turns based on the strategy S3. Actually, they counted the number of enemy posts about 21, but none of them worked. This reinforced that if students follow this strategy they will certainly fail. There were 5 turnovers under S4 strategy accounting for 8.33%.

There were 1 (1.67% accounted for) turnover of the child who succeeded by playing under the S5 strategy. They played this strategy all failed the first time. For example, the playing process of HA8 was as follows:

- "First time: count 24 flags, resulting in 3 unpinned flags.

- 2nd time: take 21 flags, successful result.

- 3rd time: take 21 flags, successful result"

Apparently, HA8 failed at first. Later, she found that she had taken the three flags in the first. This also implied to her that there were 21 enemy posts. Thus, in the second and third rounds, she only took 21 flags. However, the success of this child was not derived from counting the number of enemy posts and counting the number of flags. She acted in the following process: count the number of flags to determine the number of enemy posts (see the excess is reduced, get more), then count the number of flags. This process is also successful, but at least they have to fail once in a while. The success of the first time is just lucky. In Phase 2 of the game, none of the children took the number of flags prepared in advance.

Table 4: Statistics of students' strategies in Phase 3

	Strategy **S1**	Strategy **S2**	Strategy **S3**	Strategy **S4**	Strategy **S5**
Numbers	10	4	1	3	0
Percentages	55.56%	22.22%	5.56%	16.66%	0%

The teacher changed the number of enemy posts that made the break for the players. Obviously, after the group discussion, they all agreed to take 21 flags because they had counted 21 enemy posts. That also added to the personal relationship with the students. For example, HA3 took 21 flags in the first game. This child did not care about the teacher's announcement of changing the number of enemy posts. This confirmed that HA3 was very confident in the results of the previous group discussions. This child was not flexible to redefine the enemy posts. Some of the children rushed to count the number of enemy posts as soon as the teacher announced the change of the number of enemy posts. They really cared about the number of enemy posts before taking the flags. Indeed, they prompted their friend to play in three rounds in phase 3. All S1, S2, S3 run failed. A large number of games fell into the S1 strategy (10 turns: 55.56%). They randomly picked up the number of flags and brought them into enemy posts. Most of them randomly took turns in first and second turns.

4.1 The appearance and progress of the meaning of "*denote the class of equivalent sets*"

The percentage of children using the S4 strategy was 16.66%. Obviously, this rate was higher in phase 2 (8.33%). It also added that the discussion was more helpful for the children to play the game successfully. It should be emphasized that some students came to count the number of enemy posts as soon as the teacher announced the number of enemy posts changed. Although they were not allowed to participate in Phase 3, we believe that if they were involved, some students would be successful. Thus, until the third phase, some students discovered the corresponding 1-1 property of the count and applied it to their strategy of playing.

However, thanks to their friend's reminder, the children participating in phase 3 plugged in the enemy posts successfully. For example, in their third turn, HB4 and HA8 succeeded. The game progression of HA8 was recited as follows:

- First time: His friends reminded 24 enemy posts, but he randomly took 27 flags, the result failed.

Team B said: "Less, less"

- Second time: He randomly took 22 flags, the result failed.

Team B said: "24 flags, 24 flags"

- Third time: He counted 24 flags with the successful result. "

HA8 was reminded that there were 24 flags, but he still randomly picked the flags in the first and second turn. It was not until the third turn that he counted 24 flags.

Despite being reminded by his friends, HA2 was still unsuccessful.

"- 1st time: He randomly took 28 flags, the result failed.

HA6: "Many sandboxes too! You take it all away. "

- 2nd time: take the number of flags, the results failed.

- Third time: The student was reminded of 35 enemy posts, but he randomly took 25 flags, the result was unsuccessful"

After the HA2 was reminded by HA6 "*Many boxes of sand! You take it all away"*, then she acted according to his friends' instructions. However, HA2 still failed. This child saw too many boxes of sand, so he was thinking of getting all the flags. This was also shown in HA3's turn. HA6 reminded HA3: "*Take all flags*". Although HA6 was not played in Phase 3, he gave priority to the strategy S2 in the game. Indeed, in Phase 2, he estimated the number of flags for the second and third turns.

Some of the students were reminded by their friends, but they still acted in a personal way. Typical case was HB10. Although his friends reminded him: "*24 flags that you, dear" "count... count... count*", he played in three times randomly. As a result, he did not succeed for all three turns.

Phase 4: Both teams offered two ways of playing their team. However, only Team A discovered 21 flags by counting 21 enemy posts, while Team B used the estimation strategy. Consequently, Team B encountered the fierce debate, of Team A. Then, under the guidance of the teacher, they came up with the process of playing to win *"Count the enemy posts before, count the flags after"*. In particular, the teacher recorded it on the board. Implicitly, the teacher introduced a new meaning of natural numbers, ie solving situations with simultaneous effects of the two mathematical problems stated.

5. Conclusion

Through the experiment, the following results were achieved. Most of the playing times were not effective. That asserted that they were really having trouble with the given situation. Although they discussed the group before joining the game in phase 3, but a large number of players also continued to fail. At the end of the game, they had access to natural numbers in the sense of "*denoting the class of equivalent sets*" due to their teacher's guidance in the final phase. In general, research objectives have been achieved. Pedagogical games are not only designed to teach the meaning of mathematical concepts, but also to teach other topics. Through this paper, it is necessary to have more teachers design pedagogical games in teaching mathematics.

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