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A Pedagogical Synergy of Visualization Pictures and Scenarios to Teach the Concept of Parallelograms

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Abstract: Many problems in geometry require students to perform a number of steps in a particular order using congruence theorems. According to "the Mathematics Intermediate Level – 8th year Book, Puissance Collection" set by the mathematics curriculum in Lebanon, a new spirit conserving the individual construction of notions is advised. However, in practice this new spirit is not smoothly delivered to students. In this study, we observed the effect of the Active Learning Process in the chapter of "Parallelograms" in the 8th grade Math classes on students' academic realization, concept learning and approach changes, according to their results combined with their feedback. It was detected that after comparing the test scores of the active learning model which uses figures and models is more successful than the traditional teaching methods since there was a rise in success in students' results.

Keywords: Parallelograms; Lebanese curriculum; 8th grade; active leaning

Introduction

Context

Many problems in geometry require students to perform a number of steps in a particular order. According to my teaching practices advanced students not only remember the steps, they know when to use particular congruence theorems, they understand why they are doing what they are doing, and they know when the order of steps does or does not matter.

As stated by its authors, the Mathematics Intermediate Level – 8th year Book, Puissance Collection, deals with the mathematics program in Lebanon with a new spirit conserving the individual construction of notions, formation of communication and critical thinking skills, and preservation of the link between mathematics and the situations of our daily life. However, in practice this new

spirit is not smoothly delivered to students, and some major constructs in geometry are not delivered properly.

Research problem

Furthermore, some Geometry notions are introduced by using the direct instruction strategy. Specifically, in the topic of Parallelograms, as covered in the above mentioned textbook, Grade 8 students often do not recall and visualize the convenient properties of parallelograms required for proofs and problems involving reasoning skills. This may be due to the fact of pure memorization which eventually might increase the risk of memory loss. Students normally memorize properties; hence they are not visualizing the problem in all its aspects and making the required connections to remember the needed properties for every exercise(Cobb, 1988).

Thus concepts will not be built up properly in the students mind, and eventually less proficient students may need extra help in understanding the reason behind every step of the problem[1].

Interest of the Study

The proposed approach to help overcome this research problem is using the cognitive theory (Bandura & Ross, 1961; R. M Gagné, 1959; R.M Gagné, 1985; Piaget, 1969) and the constructivist theory (Bruner, 1986). It will be implemented using the active learning strategy: The teacher will be organizing the work by creating an active learning situation (Prince, 2004; Race, 1993; Vellas, 2008) formed of a series of activities where the student will answer a series of guided questions allowing them to recognize and deduce the properties of parallelograms which will be discussed later. Accordingly, this will test the enhancement of the learning by discovery and the comprehension of properties rather than having them being listed on the board or dictated to the students. The use of active learning in this approach is aiming to ensure the grasping of the concept where the students can now visualize and verbalize mathematics.
The aim of this study is to explore the constructivist active learning strategy through visualizing pictures and scenarios in addition to its effects on:

1. Student's Academic Achievement
2. Concept learning of Parallelograms

Outline of the Solution

Theoretical Framework

Constructivism approaches to teach and learn are the results of the work of psychologists and educators such as (Bruner, 1986; Piaget, 1969).
(Piaget, 1969), the pioneer in the constructivist theory, believes that "every learner is a constructor".

[1] National Council of Teachers of Mathematics, Commission on Standards for School Mathematics. *Curriculum and Evaluation Standards for School Mathematics.* Reston, Va.: The Council, 1989

Accordingly, there are two major aspects of the constructivist perspective: Cognitive Constructivism and Social Constructivism:
For the cognitive constructivism "Learning is something that takes place inside a person's head in the brain"(R. M Gagné, 1959). For this author, the brain is similar to a processor that manages, treats and resolves situations.
The social constructivism (Vygotsky, 1934) adds to the inner learning process the dimension of the contact with others to build knowledge.

However in this study we are interested in the common points of those two strands.
According to Piaget every learner could construct his own understanding. "Knowledge is actively constructed by the learner and not passively received from the environment". (Piaget, 1969).
(Jonassen, 1994) description of the general characteristics of constructivist learning environments is a brief summary of the constructivist perspective. This author proposed that there are eight characteristics that differentiate constructivist learning environments:

1. "Provide multiple representations of reality.
2. Multiple representations avoid oversimplification and represent the complexity of the real world.
3. Emphasize knowledge construction instead of knowledge reproduction.
4. Emphasize authentic tasks in a meaningful context rather than abstract instruction out of context.
5. Provide learning environments such as real-world settings or case-based learning instead of predetermined sequences of instruction.
6. Encourage thoughtful reflection on experience.
7. Enable context- and content- dependent knowledge construction.
8. Support collaborative construction of knowledge through social negotiation, not competition among learners for recognition." (Jonassen, 1994).

In this research, I will enhance my strategy development founded on the above mentioned characteristics.
In the classroom, the constructivist approach brings out different teaching practices. In this strategy, I usually encourage students to be active by choosing several techniques as experiments and real-world problem solving. They should be encouraged to search, create, reflect and negotiate their knowledge and their understanding in order to rectify them if necessary. My role as a teacher is to guide the students and to act as a mediator who organizes the students' understands and controls their activities.

Constructivist teachers encourage students to constantly assess how the activity is helping them gain understanding. By questioning themselves and their strategies, students in the constructivist classroom ideally become expert learners[2]. This gives them ever-broadening tools to keep learning. With a well-planned classroom environment, the students learn how to learn.

[2] http://www.thirteen.org/edonline/concept2class/constructivism/index.html

Based on the above, it is clear that the active learning process complements the constructivist theory and is a fundamental asset for teaching and learning. It is in fact a realization of the constructivist theory.
"The normal way of acquisition is not observation, explanation and demonstration; it is the experimental trial and error, natural and universal approach"(Freinet, 1964).

(Akınoğlu & Özkardeş, 2007) indicated that in the student-centred active learning process the teacher is merely a guide, which is the focal point of contemporary educational systems[3].
According to (Akınoğlu & Özkardeş, 2007) "the active learning is a process in which the learner takes responsibility of his or her learning and is given the opportunity to make decisions and inferences for the goal of self-regulation. In this way, learning will no longer be a typical process, but it transforms into a personalized process based on every student's needs and reflections". This author believes that active learning provides the learner a background to self-criticism and an autonomy to choose his own path to resolve problems. Moreover, students will develop their skills of problem-solving and critical thinking to learn (Bonwell & Eison, 1991).

In this process, the students shall be ready to solve any problems they encounter in their everyday lives.
On another hand, the study shows that as (Akınoğlu & Özkardeş, 2007) concluded "the problem based learning model turns the student from a passive recipient to an active self -learner and problem solver shifting the emphasis of educational programs from teaching to learning" (Akınoğlu & Özkardeş, 2007). In this strategy the student becomes responsible of his own acquisition and learning.

Not to forget that students attitude in the areas of problem solving, thinking, communication, group work, information acquisition and information sharing are affected positively. Note that the students' feedback is to be considered but not fully reliable (Al-Issa & Sulieman, 2007; Boysen, 2008). In fact, even though, gathering information from the students' feedback is suggested, their comments and observations remain highly subjective and not mature.

Functional Framework

Grade eight students[4] consider problems in geometry as something abstract, complicated, and incomprehensible. On another hand, students are introduced to the concepts of proofs and statement/reason which in its turn requires a lot of visualization and conceptual understanding. This is because in each exercise students explore a new situation and are required to use their prior knowledge to make decisions, inferences, and generalizations.

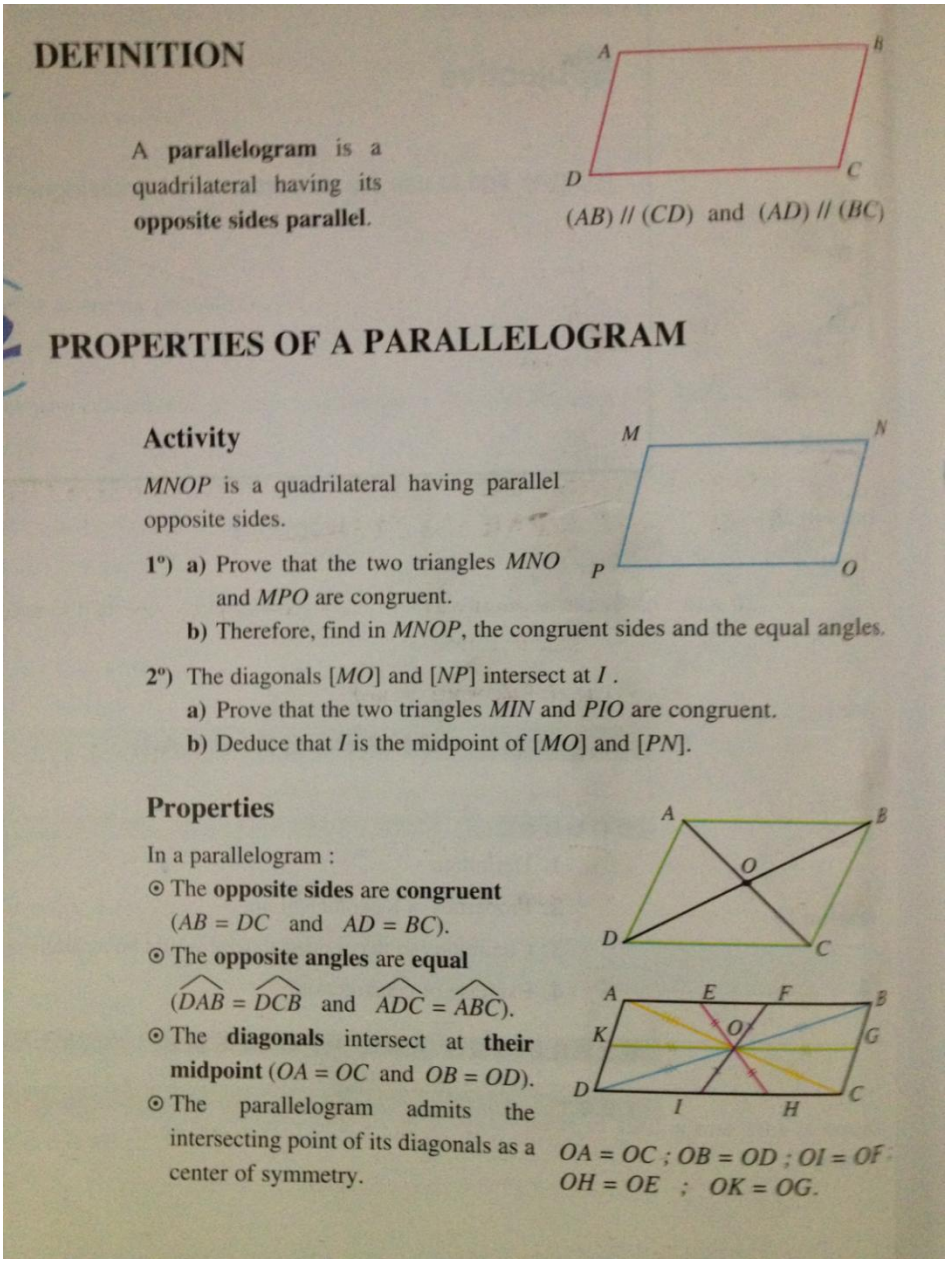
[3] Mentioned in: 2007 Moment, Eurasia J. Math. Sci. & Tech. Ed., 3(1), 71-81
[4] Grade 8: 13- 14 years old

The purpose of this research is to conclude whether the application of the active learning model in "Parallelograms" chapter of the 8th grade in the Intermediate Education brings out major modifications to students' academic accomplishment regarding their concept learning and their approach towards the math class.
This framework will be implemented using the active learning strategy. The teacher will be organizing the work by creating an active learning situation formed of a series of activities where the research group students will individually answer a series of guided questions about parallelograms allowing them to recognize and deduce the properties of parallelograms by themselves. In this way, they would be able to perform similar analysis on any problem they occur and require higher order thinking skills.

For the other group, the control group, a traditional strategy is applied: In the School Book[5] this chapter is normally introduced using the direct instruction approach, that is the uni-directional transmission mode of learning: The teacher provides the students with the definition of parallelogram, its properties, and then listing the conditions required to prove that a quadrilateral is a parallelogram. There was neither discussion nor exploration of the concept (See Figure 1). In general, the teacher reveals the Parallelogram proprieties as follows:

1. A parallelogram has opposite sides parallel and equal in length.
2. A parallelogram has its diagonals bisect each other.
3. A parallelogram angles opposed to same extent
4. If an uncrossed quadrilateral has its parallel sides of the same length, then it is a parallelogram
5. If an uncrossed quadrilateral has diagonals that bisect then it is a parallelogram.

5 Mathematics - Intermediate Level - Collection Puissance - 8th Year - 2007 - Al-Ahlia



DEFINITION

A **parallelogram** is a quadrilateral having its **opposite sides parallel**.

$(AB) // (CD)$ and $(AD) // (BC)$

PROPERTIES OF A PARALLELOGRAM

Activity

MNOP is a quadrilateral having parallel opposite sides.

1°) **a)** Prove that the two triangles *MNO* and *MPO* are congruent.

b) Therefore, find in *MNOP*, the congruent sides and the equal angles.

2°) The diagonals [*MO*] and [*NP*] intersect at *I* .

a) Prove that the two triangles *MIN* and *PIO* are congruent.

b) Deduce that *I* is the midpoint of [*MO*] and [*PN*].

Properties

In a parallelogram :

- The **opposite sides** are **congruent** ($AB = DC$ and $AD = BC$).
- The **opposite angles** are **equal** ($\widehat{DAB} = \widehat{DCB}$ and $\widehat{ADC} = \widehat{ABC}$).
- The **diagonals** intersect at **their midpoint** ($OA = OC$ and $OB = OD$).
- The parallelogram admits the intersecting point of its diagonals as a center of symmetry.

$OA = OC$; $OB = OD$; $OI = OF$; $OH = OE$; $OK = OG$.

Figure 1: Passive method

In this research, I will prepare in advance an activity concerning the parallelograms chapter and explain it to the research group. Students will answer the sequential questions in the assistance of two faculty members: A colleague and myself. Both faculty members had previously taught the "parallelogram" chapter. Consequently, students deduce the definition, rules, and properties of parallelograms.

Noting that, the two groups are equivalent and homogeneous; they have been following the same program in the same school from the early elementary classes.

Exploring Parallelograms will be as follows:

1. Draw any 2 points A and B
2. Use the ruler to draw from each point two parallel lines
3. Connect point A to B
4. Draw a fourth line parallel to (AB). Name it (DC)
5. Answer the following questions:
    a. Measure AB and CD. Compare the results
    b. Measure AC and BD. Compare the results
    c. Find the measure of $\widehat{A},\ \widehat{B}, \widehat{C}, and\ \widehat{D}$. Compare: $\hat{A}$ and $\hat{C}$
       Compare: $\widehat{B}$ and $\widehat{D}$
    d. Connect AC and BD. Name their point of intersection M
    e. Measure MA, MB, MC, and MD. Compare.

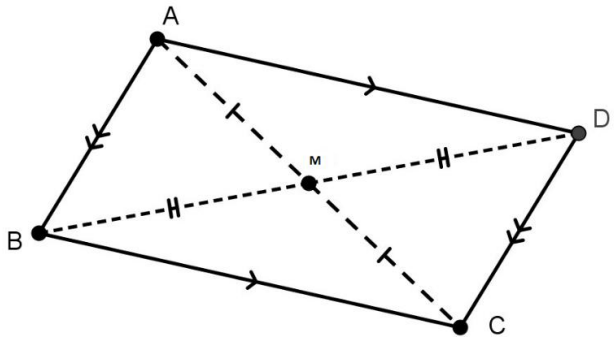


Figure 2: Active method to teach parallelogram properties

Eventually, there will be class discussion about the results. Accordingly, students will deduce the definition of a parallelogram, its properties, and the requirements to prove that a quadrilateral is a parallelogram.
The parallelogram properties to be discovered by the students are the following:

1. Two pairs of opposite sides are equal
2. Two pairs of opposite angles are equal
3. Diagonals bisect each other

How to Analyse the Method

The analysis will be done objectively by the two faculty members, a teacher and myself as the researcher. A unified test is assigned to both groups: The control and the research. Then the results are recorded separately by the two faculty members. To be noted that, for the research group, the method is introduced and completed interactively before the students perform the unified test. These assessments will ensure the reliability of the results. Moreover, students' feedback taken by the two faculty members from oral opinions and comments will be a source of evaluating the new method in terms of interest and motivation for the math lesson and opinion about the problem based learning. Since one should not forget the role of students' motivation in the grasping of the concept acquisition. Motivational issues play a strong role in the development of conceptual skills (Klausmier, 1915). Therefore, a combined, quantitative and qualitative analysis research methods were used in this study

by both faculty members. In quantitative research dimension, the test model is based on the unified test given to the control and the research groups. In qualitative research field, students' attitudes and reflections were noted for evaluation.

Methodology

Situation

This study was performed on the students who were at the 8th grade of the Intermediate Division of Sagesse High School in Lebanon during the 2012/2013 academic school year. The 50 homogeneous students were randomly divided into two sections encompassing 25 students in each section. In addition every group receives 6 math sessions per week, and the number of contact hours that were required for this task were 6 periods (hours) for every group. Moreover, the students' academic achievement and concept learning levels regarding "Parallelograms" were considered.

Application

With the above mentioned aim and objectives, I prepared a unified test including 12 questions. This test was presented to the 8th grade students in the attendance of their teacher. 50 students were participated in the research in total. After completing the traditional model, the unified test for the control and research groups was the following (Figure 3):

I. Answer by true or False

1) In a parallelogram, any two consecutive sides are congruent
2) In the parallelogram $MNPQ$, [MN] and [PQ] are the diagonals
3) The sum of the measure of the angles in a parallelogram is 180°
4) In a parallelogram, any two opposite sides have the same perpendicular bisector

II. Answer the following questions.

1) Name all properties of a parallelogram
2) What is the intersecting point of the diagonals in a parallelogram called?
3) Let EFGH be a parallelogram with center O
   a) $FEH = 60°$, calculate the other angles of the parallelogram
   b) If EH = 16, calculate FH.
   c) If OF = 9, Calculate FH.

III. Perform the following constructions

1) Construct a parallelogram ABCD such that: $B\hat{A}D = 120°$ $A\hat{B}C = 80°$, $AB = 6\ cm$
2) Construct a parallelogram $EFGH$ such that $EF = 7\ cm$ $EG = 4\ cm$

IV. Proof (6 points)

1) **Given** $MNPQ$ is a parallelogram with center O
   PE = NF
   Prove:
   a) OE = OF
   b) MFQE is a parallelogram

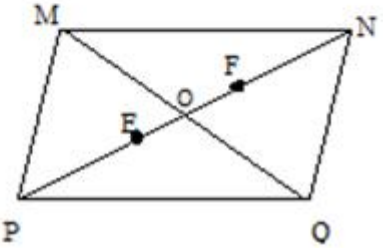


Figure 3: Test given to the Control group

For the control group, students' test feedback had varied. Some students did really well, but the majority did not meet the requirements. Consequently, the research group had the time for the active method implementation stimulating the brain with the activity about the parallelograms and answering the guided questions (Figures 4 and 5). The results of the students had changed remarkably. They showed a notable interest to the learning by discovery and were so excited to the deduction of properties and making generalizations.

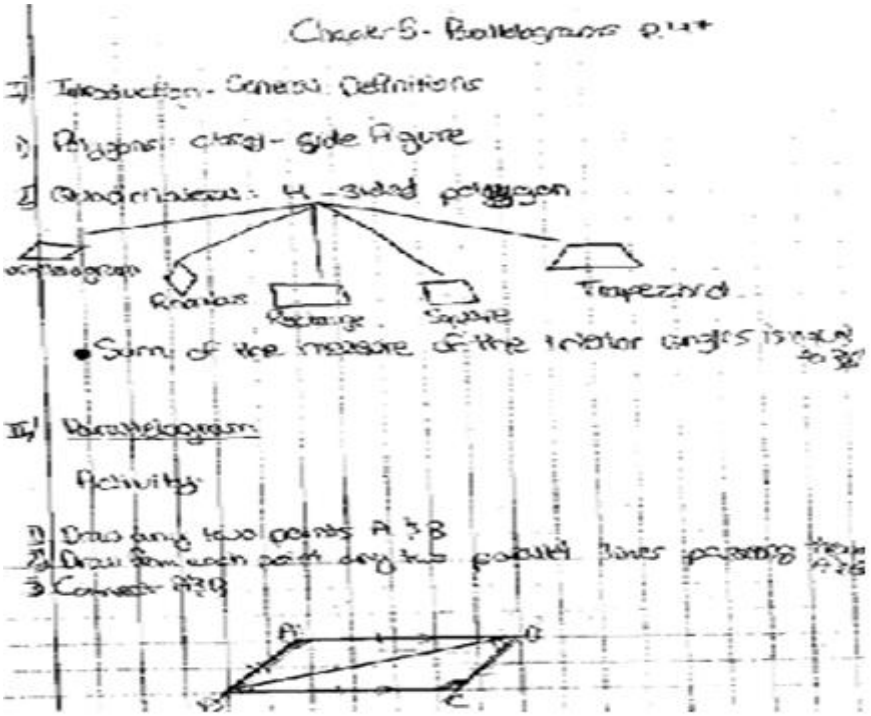


Figure 4: Student' activities following an Active method

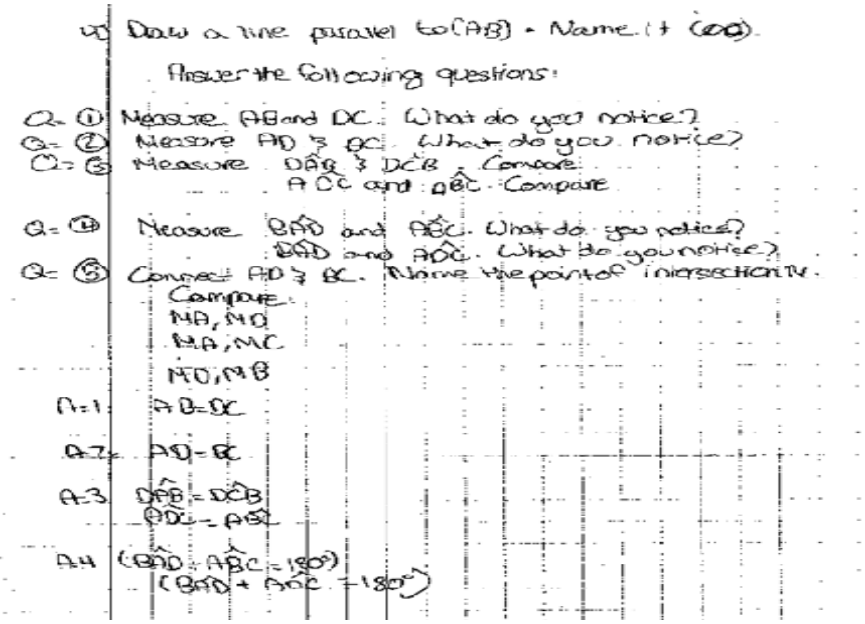


Figure 5: Student' answers following an Active method

After completing the sequential questions, the unified test (Figure 3) prepared in accordance with the objectives and the acquisitions in the subject matters of "Parallelograms", was given to the research group in the presence of their teacher and myself. This topic was divided into sub concepts and the 12 questions asked covered the knowledge, comprehension, and analysis of the concepts.

Through this process, we noticed that from our observation using a student-centred strategy, knowledge and connections were transferred to the students and among the students as well. To be noted that, this active method has been prepared and implemented after having the approval of the subject coordinator and the educator.

This test gained positive feedback from students especially those who had difficulty in grasping the concept of parallelograms inductively.

Data Collection

Knowing that the expected learning outcomes are:

1. Construct parallelograms having a specific given condition
2. Recognize a specific parallelogram property and apply it in a problem situation
3. Prove that a quadrilateral is a parallelogram using a logical reasoning.

In accordance with what was previously mentioned, the results of the test presented to the control and research groups are summarized in the Figure 2 below:

	Meeting the expectations	**Below the expectations**	**Total**
Control Group	21	29	50
Research Group	37	13	50

Figure 6: The results of both groups

On another hand, the students' valuable feedback present part of the qualitative data collection. Some relevant opinions expressed by students from the research group during the activities are given below. They had mentioned that they now understood the reason behind every property.

A.M: "I liked this very much. The guided questions helped me to think about the properties of the parallelogram independently."

J.K: "In this process of learning by discovery, it is so easy to answer the questions, and it is so good and fruitful to discuss them with the whole class."

C.C.H: "I like this system in math very much. I can now understand the Math course better because the activity is hand into us earlier. The problems are made so easy now."

T.R: "In my opinion, this active learning approach attracted me. It is a good method. We are learning by having fun."

Analysis of Data

The analysis of the implemented method can be considered at two levels, the quantitative analysis, and the qualitative analysis.

Starting with the quantitative analysis, we can see that before the active learning method has been implemented, 58% of the students were having the results below the expectations according to their teacher and myself as the conductor of this research. However, after the implementation of the active method, this has decreased to become 26%. This ensures the improvement in the performance of 55% of the students who had difficulties[6]. (See Figure 7)

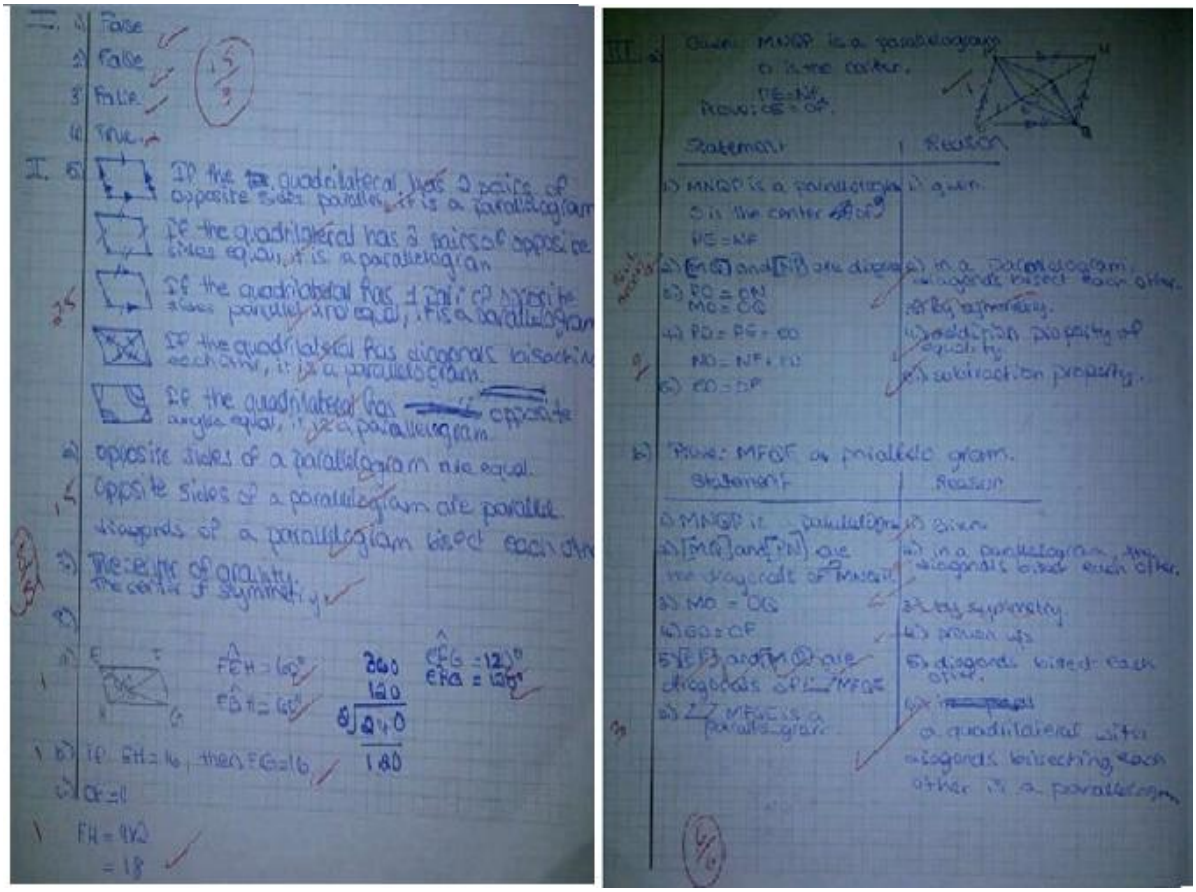


Figure 7: Student' test answers from the research group

At the qualitative level, the students' feedback about my active method showed that they find great interest and enthusiasm when they learn parallelogram

[6] More details about students' answers to be requested from the author

through an active engagement process and in a problem-based active learning application. Moreover, even if every student happened to construct a parallelogram with different dimensions, they noticed that the properties end up being the same. In addition, translating figures or flipping them in the pages created a class discussion process which allowed students' communication and sharing ideas. Therefore, the active method had a constructive effect on the students' concept development by teaching them self-sufficiency and autonomy in acquisition new skills. Thus the concepts learned become more effective and a long-term stable.

"We learn by understanding, not by following a path all drawn" argued (Piaget, 1969), learning the material comes with understanding and not only from listening.

(Gremmels, 1995, p.89) advocated: "When we use the dump truck method, we overwhelm our students with more skills and strategies than they can possibly absorb in an hour. That's our first mistake. Then we fail to give students the opportunity to practice any of the strategies and skills, virtually guaranteeing that they won't be internalized."(Gremmels, 1995, p.89)
In this study, the result of implementing an active method to learn "Parallelograms" supports and joins the author's opinion about the passive method whereby:

1. All the students receive the same content from the teacher, despite their mind capacities.
2. The students are passive recipients. Their critical thinking is short-cut.
3. The students are not encouraged to self-learning; they remain dependent on me as a transmitter of knowledge.
4. The teacher goes on with the advancement in the math curriculum whatever is the understanding of his students.
5. The collaborative learning in group is minimized.
6. The students may not transmit their knowledge in future skills

It was what (Gremmels, 1995, p.89) meant about the disadvantages in adopting a passive method in teaching which I strongly approve according to data analysis of my active method.

Conclusion and Perspective

In this study, in which the effect of the Active Learning Process in the chapter of "Parallelograms" in the 8th grade Math classes on students' academic achievement, concept learning, and attitude changes were examined, following results were obtained. It was observed that after comparing the test scores, the method which uses the active learning model is more successful than the traditional teaching methods since there was a rise in success in students' results. Therefore this verifies the hypothesis claiming that "Teaching Parallelograms in geometry using the active learning constructivist approach has effect on student achievement". In fact, (Akınoğlu & Özkardeş, 2007) showed that "the active learning methods are more effective than the classic method by relying on the findings of their research conducted on the basis of problem-based learning, brain storming, and cooperative learning".

When examining the students opinions about classes in which active learning strategies and problem based learning is used, it is noted that the visualization through pictures and scenarios of the problem models were very successful in capturing the attention of the students to the classroom. Thus this has been quite influential regarding the attitude of the students towards the math class.
At the end of the studies carried out with the students through the active learning strategy regarding a simple yet basic concept in math, Parallelograms. I observed that their cooperation with each other, accepting others perspective and opinions, and social development were positively enhanced in addition to improvement in the knowledge construction.

As a conclusion, it is revealed that the active learning constructivist approach affects both the teaching and learning process positively. The rise of the students' social development, information dissemination, and problem solving is unavoidable in the class encompassing an active learning process.

These qualities are essential in term of academic math education at all levels and in diverse cultures. Nevertheless, there exist some limitations and barriers to the use and implementation of the constructivism and active learning practices. They include the following:

1. The limited time frame that bounds the completion of the academic program in a school year might not allow the teacher to use the active learning and constructivism strategies properly.
2. The number of students per class might create a barrier to the proper implementation of the theories discussed above.
3. Not to forget, the willingness of teachers and their encouragement to those topics and educational approaches, especially those who have years of experience and might be not very cooperative in doing any development/update in their teaching strategies.
4. Last but not least is the constant and regular accordance of the superiors and coordinators that should exist in order to legalize the implementation of the latest trends in education.

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