

Applying Interactive Teaching in Teaching Mathematics at High School in Vietnam

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Abstract In the process of modern teaching, the interaction between factors in the teaching process is very important. Looking at some point, it must be seen as a key principle of modern teaching. That is, no matter the objects and contents of teaching for one to teach and learn well, it is necessary to have a positive interaction between the learners and the elements of the teaching process. Interactive teaching has become one of the new trends in teaching and learning methods in Vietnam today. In this article, the author presents an overview of interactive teaching: Characteristics of interactive teaching; The elements of interactive teaching are the teacher, the learner, the environment and the interaction between these factors and the basic principles of the interactive teaching and its viewpoint. The author also presents the stages of interactive teaching and the examples which illustrate the application of interactive teaching in teaching mathematics in high school.

Keywords: *interactive teaching, teaching mathematics, interaction, environment, interactive pedagogy*

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1. Introduction

Interactive teaching is studied and applied in many countries in the world. In the 1990s of the 20th century, a group of French authors who are Guy Brousseau, Claude Margolinas, Claude Comiti,... had also done studies about the interaction among the elements of teaching activities in the situational theory of mathematics [[1]; 115]. Guy Brousseau had studied the interactions and mutualities between the teachers (teach) - the learner (learner) and the environment during the teaching process. Where the environment had been considered from the point of view of situations. In this view, there are two types of situations in teaching, they are the didactic one and the a-didactic one. In two works, "Toward an Interactive pedagogy Method (Trilogy: The Learner - the Instructor - the Environment)" [2] and "Pedagogy interacts with a neuroscience approach to learning and teaching" [3], Jean-Marc Denomme & Madeleine Roy had initiated a pedagogical approach which is called the interactive pedagogy. These two books describe the interaction between the three actors in the teaching process: the teacher, the learner and the environment. The interaction of these three factors is good or not, this is the reason for the quality of teaching is good or not. Recently, in the book "The construction of new mathematical knowledge in classroom interaction", the author Heinz Steinbring [4] also proposed an approach to teaching based on this pedagogical opinion. In this book, Heinz Steinbring gave

the basic concepts of background theory and the main features of how research methodology is chosen in interaction in mathematics classes.

In recent years, Vietnamese teachers have talked much about this new pedagogical thinking. In the book "Applying theory to the practice of mathematics in high school" [5], Bui Van Nghi presented briefly the use of interactive theory in teaching some of the contents of Math program in general. In the Doctoral thesis of Education "Organizing teaching according to the interactive pedagogical opinion in school (department) of education managers and education nowadays" [6], Nguyen Thanh Vinh also presented some the basic problems of Interactive teaching method. In the book "Teaching and teaching method at school" [7], Phan Trong Ngo discussed the interaction between the teacher, the learner and the object of teaching.

In the book "Traditional and Innovative teaching methods", author Thai Duy Tuyen has also presented the concepts of interactive pedagogy, the types of lessons in interactive pedagogy and the types of interactions in teaching. In the book "Methodology and teaching technology in interactive pedagogical environment" [8], Pho Duc Hoa has given the reader an overview of the interactive pedagogical model and the application of teaching methods and technologies in this environment at different types of schools. Most recently, the work "Teaching organization based on learner-learner interaction" [9] by Ta Quang Tuan and Do Thi Thu Huyen has proposed measures and techniques for teaching organization rely on the interaction between the learner - the learner in the universities. Besides, there are also many articles such as

[10,11,12,13], which refer to this teaching view applied in other subjects as well as in elementary school.

Nowadays in Vietnam, this method has been used but not widely at some high schools. The application of interactive teaching is reflected most clearly through the contest for solving mathematical problems through the internet for primary students by using Interactive Mathematics Learning Resources of Hoang Khanh Hoa which was introduced on the Internet [14]. Interactive Mathematics Learning Resources attracted the participation of many primary and secondary students as well as parents.

In teaching mathematics in Vietnam today, there has been an interaction in teaching, but that has not yet clear, mostly that has been one-way interaction between teachers and students, and the interaction between learners and the environment has still been faint. In this paper, the author hopes to give the reader an overview of interactive teaching and using this teaching perspective in teaching mathematics in high school.

2. Content

2.1. Learners, Teachers, Environment in Interactive Teaching

* Learners - active workers

As a factor in the Interactive teaching opinion, firstly, learners are people who go to school but they aren't people who are taught the learners who are not taught. In the process of cognition, learners must build on their own potential, and exploit experiences and knowledge which has been accumulated by them to reach out and discover new horizons. Thanks for the excitement, the learners participate actively and continue their learning process by setting the task of learning for himself and completing it. At the same time, learners must take part in the collective learning project; fulfill their learning task that has been set.

* Teacher - guider

The teacher is a person who, by his or her knowledge and experience, acts as an organizer; guider and control of learner to take part the learning activity. The teacher helps learners understand the goals they must achieve, arranges content, selects teaching methods and builds an friendly environment that makes learners more motivated to learn and bring them to the goal. Teachers need to create opportunities for learners to be acted, to be expressed themselves and to assert themselves, to avoid the imposition of one-way information. The main function of the teacher is helping the learner to learn and to understand. The teacher serves the learner and must develop their knowledge in the manner of the guider.

* Environment - affects the entire teaching process

The environment is all the factors and surrounding conditions that impact immediately on the human. The environment is considered in a variety of contexts: the physical environment and the mental environment, the broad environment and the narrow environment, the internal environment and the external environment, all of them create the learner and teacher's environment. The environment is the factor that can have a negative or positive effect on both the teacher and the learners. In addition, the teacher and learners can also react the

environment to adapt to it. Therefore, the environment plays the important role in teaching and learning.

The Interactive teaching environment consists of many components, including 3 main components: knowledge, Interactive teaching situation and teaching aids.

2.2. Interaction between Learners, Teacher and Environment

Interactive teaching is basically based on the mutual relationship that exists between the three actors, the learners, teacher and the environment. These three factors always interrelate with each other, so that each one of them acts and responds in the influence of the other.

Learners in their learning method impart information to the teacher by words, by comments, by questions or by attitude, gesture or behavior, etc.... The teacher responds with providing learners with additional information, the answers the questions which have been made by learners, or motivates learners, adjusts teaching activities, etc... Thus, the learners take action and the teacher responds. That is the interaction between the teacher and learners.

For teacher, who teaches in their pedagogy method, the teacher suggests to the learner the direction to overcome, the means to be used and the results to be had to achieve. If the learners feel interested, the learners will feel sympathetic towards the teacher easily and study better. On the other hand, if learners feel discouraged or lack interest, it will interfere with their learning. At this point, the teacher acts and the learners react.

The environment always affects learners and teacher. This influence creates favorable or unfavorable conditions for the learners. For example, if learners and teacher implement teaching activities in a dark and cramped room, they will feel uncomfortable. The environment has affected the learners and the teacher. Their uncomfortable feeling is the reaction, which results in the interaction between these three factors. The interaction between the learners, the teacher and the environment are the nucleus of the interactive teaching viewpoint as shown in Figure 1.

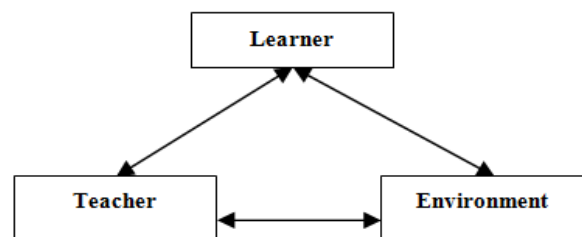


Figure 1. Relationship between the three factors in Interactive teaching

Thus, interactive teaching specifically increases the value of interrelated relationships that exist between learners, teacher and the environment in the teaching process. The diverse participation of these three factors in the process of teaching is the source of dynamic relationships among them and the most characteristic element of this pedagogic opinion.

2.3. Basic Principles of Interactive Teaching Opinion

Interactive teaching is based on the following principles [2]:

2.3.1. The First Principle: Learners - workers (Learners are the Main Factor of Learning Activities)

The Interactive teaching view considers the learner as the main worker of the training process. Learners are the decisive players, the first factor to implement the learning method and take self-responsibility during the learning process. Learners are able to tap experiences, accumulated knowledge to approach, discover the truths, emotions, comprehend knowledge and practice skills. Thus, the learner with the necessary abilities is capable of acting as a main worker by participating actively in the learning process. That stimulates the learners' dynamic and effort to complete their work.

2.3.2. The Second Principle: The Teacher - the guider (the Teacher is the Main Interpreter Next to the Learners)

The teacher is the same the captain who turns the ship's steering wheel to the learners - the member of the crew. The teacher must try to help the learners and facilitate the learning method of the learners. The teacher has the role of building a plan, conducting activity and cooperating in the process of guiding the learners.

2.3.3. The Third Principle: Environment and the Impact of the Environment (Environmental Impact on Pedagogical Activities)

The environment affects all pedagogical activities, which affect the learning method, the pedagogical method and they always have interactions between them. Every learner and the teacher have their own personality, which is characterized by temperament, genetics and education. There are many situations that affect the learner's performance and the teacher's behavior, which come from outside sources such as: family, school and society.

Conversely, the teacher and learners are able to react with the environment to change it. This asserts that the interdependence lies in the interaction between the learners, the teacher, and the environment.

2.4. Characteristics of Interactive Teaching in Teaching Mathematics

Through research on the relationship between interactive teaching and other teaching methods, the basic characteristics of interactive teaching can be stated as follows:

- Interactive teaching is done through interactive teaching situations.
- Interactive teaching focuses on creating an interactive environment where activities take place, interactions between students and students, between students and teachers, between students and teaching and learning tools (documents, textbooks, computers, internet, ... etc.) that affect teaching and learning activities directly.
- Enhance the positive and active role of each student in interaction with other students, teachers and the environment.
- The evaluation of learning results is done through interaction between each student with students and with teacher.

2.5. The Stages of Organizing Interactive Teaching in Teaching Mathematics

2.5.1. Preparation Stages

2.5.1.1. Build a lesson plan

Building lesson plans is a very important part of teaching process. This stage requires the teacher to prepare well before coming to class, so the teaching process is very effective. Applying Interactive teaching to building the lesson plan means the determining of the objectives and contents of the lesson that can organize the most appropriate teaching forms and the best interactive teaching methods. Simultaneously, Applying Interactive teaching procedures is effective. The author proposes the lesson planning procedures for Interactive teaching including the following steps:

Step 1: *find out about the learners*

Before building and implementing a lesson plan, the teacher had found out about the student's background, family circumstances and academic performance,... to define clearly for students object in their class that they will be teaching. This helps teachers to determine the target of each lesson in accordance with the program and in accordance with the general level of students in the class they will teach. Based on the understanding of the learner, the teacher builds an environment that stimulates excitement and facilitates the learners. In the allowed circumstances and conditions, teachers should organize the examination to evaluate and certify students before planning new lessons.

Step 2: *Determine the targets and contents of the lesson, select the teaching methods suitable for each unit of knowledge, determine the time of examination and evaluation students.*

The content of the mathematics textbooks in high school is usually divided into 3 to 4 different units of knowledge. For the use of Interactive teaching in teaching mathematics in high school effectively, the teacher should note the following points:

- Determine the target of each lesson clearly about knowledge, skills, attitude, thinking and demonstration of each activity of teachers and students, forms, measures to organize teaching ... to create the interest in learning for students. In the process of building the lesson plans, teachers have to rely on: Content of the program and textbooks, teachers' books, the level of students in class, the current teaching conditions.
- Use some forms of teaching flexibly that is capable of organizing the most effective interactions.
- Identify the knowledge which related to the learning content so that the learner can contact to solve the learning task.
- Project learning process, project the approach to knowledge contents, time and methods of accessing that knowledge contents.
- In each unit of knowledge, teachers need to identify the necessary levels that students need to grasp and plan the examination and evaluation students. The students' assessment also helps the teachers get the back information to make necessary adjustments and students know their abilities to adjust their learning methods.

Step 3: Determine the type of interaction and create interactive contents

To use interactive teaching in the teaching organization contents that is selected, the teacher can carry out as follows:

- Determine how to organize teaching contents (discovering, creating new knowledge or strengthening, practicing, self-study guiding,... etc.) to set up teaching process appropriately.
- Build learning situations that attract learners' attention.
- Select the appropriate teaching aids to support, express knowledge contents, enhance the interaction.
- Stimulate learners' excitement.

In the process of teaching if students are interested in learning, the information that is received from their senses will pass through the brain, and new knowledge will be raised. Therefore, creating learning excitement of students is a teaching measure that influences the success or failure of Interactive teaching. Creating students' interest in learning can be done in two ways: Create inner interest in learning and create outer interest in learning.

Create inner interest in learning: Creating inner interest in learning is often started by problematic situations that stimulate the learner's cognitive needs and come from within the subject. When the teacher creates problematic situations, it means creating contradictions in the cognitive process between the new knowledge and the old knowledge which the students have known. In addition, to create inner interest in learning of the learners, the teacher must help them gain confidence in their ability to overcome the difficulties, believe in his strength and the joy of success. For example, when a student discovers new something in a lesson or solves an exercise, the teacher should motivate, praise, and record the results of the student's achievement to help them become more confident in their studies.

Create outer interest in learning: Organizing meaningful forms of learning, activities outside the hours in many forms, the combination of using teaching aids sensibly,... That will create outer interest in learning of the students in the learning process. Therefore, creating outer interest in learning will contribute to create a favorable environment for students' learning activities.

- Develop learning situations (these are question systems, hints, instructions, etc.) to mobilize students' learning experience.

The teaching situations must be consistent with the real-life experience and experience of students. Teachers need to base on experience, real-life experience of students in certain appropriate levels to mobilize as a starting point for teaching methods. This work should be carried out during the teaching process by using a rational question systems and facilitating the student's participation in the assessment process, self-assessment and cross-examination.

2.5.1.2. Studying the design of the lecture to create the excitement for the learners, stimulate the learners' participation and responsibility

In order to prepare for a class sessions, the teacher needs to prepare for all tasks thoughtfully, such as: teaching aids, lesson plans, simultaneously the teacher has to penetrate that carefully. When the teacher is in class, they must be calm and confident, have quick style, clear

language to guide students to understand the lesson's contents easily. Simultaneously, the teacher needs to exploit the lesson's content to promote creativity of good students.

To improve learning efficiency, to create students' interest in learning in the teaching process, teachers have to prepare: teaching plan, questions system. To have good preparation, teachers need to penetrate the lesson plan carefully, understand the intention of the textbook; Has a scientific design, clear and brief questionnaire system which is easy to understand; Select effective teaching methods; Make good use of transcripts, passages, make a close links, the logic of the lesson; use the teaching aids maximally and effective in each lesson, in each subject; The teachers must have a certain amount of knowledge and social knowledge; The teachers need to create favorable conditions for students in order that they are active, proactive, and creative in gaining knowledge; Follow to the topic of the school year to plan for each months, each weeks suitable and scientifically.

- When the teacher guides students to answer the old lesson: The teacher asks the students to answer shortly, have a thorough understanding of main knowledge, answer or do exercises related to old knowledge, which the students have been learnt, complete the exercises with the fastest solution or the operation that is easy to understand.

- When the teacher guides students to learn new lessons at home: The teacher asks students had studied new lesson at home before he or she came to the class, read and done some exercises in the textbook.

- When the teacher comes to class: The teacher uses many methods such as visualization, conversation, presentation, practice. Teacher must thoroughly use the teaching aids. Besides, teachers should spend more time for students to practice to promote their imagination, creative thinking. After each lesson form, the teacher should engrave the lesson's knowledge on students' memory.

For math, to motivate students to learn, it is necessary to create learning motives, especially the inner dynamics of each student. In addition to personal factors that may create interest in learning, such as: the challenge, the curiosity, the imagination, the interaction between the elements of the teaching process will create interest in learning of students, such as: emulation, cooperation, recognition.

Here are some ways that can create interest in math learning in high school:

a) Create challenges

One of the motivating factors that motivate learning is the challenge. Learners are challenged when they aim for meaningful goals, so that achieving this goal is uncertain, but they have the belief that they are making acceptable progress. There are four factors that affect the challenge: These are the goals that needs to be achieved; Certain degree that can be attained; Feedback from the results of the effort; Self-respecting of learners.

Example 1: To create the challenges to inspire learning, teachers can assign assignments to students with difficulty levels is increased. Or it can stimulate students' self-respecting and cooperation by reminding them, "This is a difficult problem, but if you work together in learning, you can solve this problem. "

b) Create curiosity

Curiosity is encouraged when something attracts the students' attention, or when there is a degree of inconsistency in the knowledge or between current skills with the knowledge and skills that students approach while they are joining in activities. The curiosities will create students' interest in learning through the novelty and excitement of the problems. There are two types of curiosity:

- *Curiosity by senses*: Occurs when the teachers have elements such as voice, light, sound attract the attention of the learners.

- *Curiosity in perception*: it is awakened when learners believe that they will be able to expand their knowledge after learning process.

Example 2: During the teaching process, teachers can use intonation, visual images which attract the students' attention. Or while teaching the concept of complex numbers, the teachers can create curiosity as follows:

Let students solve some equations:

$$1) x^2 - 4 = 0$$

$$2) x^2 - 3x + 4 = 0$$

$$3) x^2 + 1 = 0$$

After the students have solved the equations 1) and 2) that have solutions, go to equation 3) we have $x^2 = -1 \Rightarrow$ equation has no solution, the teacher commented: "The equation above has no solution because we can not find any value of $x \in R$ so that $x^2 = -1$. In order to equations above have still solution, the Real numbers R is expanded out to be the Complex numbers C , so that the equations that are like above equation still has the solution in the Complex number field. What is the complex number? Let's get to know that things through this subject, today".

c) Create the imagination

It is possible for students to imagine that they are the same a special figure who found out new knowledge that is learning. That also makes interesting to implement the learning activities. There are two factors that affect the imagination:

- *Emotional factors*: Occurs in the teaching process, the students are able to imagine playing mathematicians when they are solving a problem.

- *Cognitive factors*: It is possible to give students more motivation to participate in the activities by showing them that they will use their math skills in real life.

Example 3: When the teacher is teaching the formula for the sum of n the first terms of an Arithmetic progression, the teacher can create the interest in learning by the following way:

"When he was in elementary school, the German mathematician Gauss had calculated very fast the sum of natural numbers from one to one hundred. According to them, how did Gauss calculate? "

d) Create the competition

Competition is one of the interactive elements between students. The competition will motivate them because they can increase their self-esteem when they are comparing their results with their classmates. This also creates students' interest in learning.

Example 4: The teacher can organize a competition solving mathematics in the form of relay (it is the same

relay – race) among groups in the class. The winning team will be rewarded.

e) Create the cooperation

The cooperation also increases the interaction between students in learning. Students will find interest in working together to aim at the goal of the group.

Example 5: Teachers divide the class into groups of students and assign tasks to discuss a problem, or work together to find ways to solve a math problem. After a certain period of time, the groups send their representatives to present their ideas.

f) Create the recognition

Most of the students want that their efforts and achievements are recognized and appreciated by others people. If the efforts or achievements of students are recognized at the class, students will be very excited to learn so as to be worthy of the collective recognition.

Example 6: Teachers can reward timely with students who are not good at learning but they have more effort than before. Or the teacher can use the following words to stimulate the students' positivity:

"This is a reward for the earliest finisher in our class" (incorporating both recognition and emulation).

2.5.2. The Stages of Interactive Teaching

2.5.2.1. The interactive activities in teaching mathematics in high school

a) Major interactive activities in teaching mathematics.

Interactive mechanism in interactive teaching is the interplay between three factors: the teacher - the learner - the environment. The interactions among three factors or between two in three factors that depend on the different conditions and circumstances. The environmental factors are considered in a dynamic state rather than a static state. As such, the environment is always operating alongside the development of the laws of teaching process, in order to meet the needs and demands of society [[27]; p. 49]. The major interactive activities in teaching mathematics are teacher - students interaction, students – environment interaction, and teacher – students – environment interaction.

b) The favorable situations for interactive activities in teaching and learning mathematics to improve the teaching quality.

- The contents of the lesson are related to reality;
- The contents of the lesson are open, there are many solutions;
- The contents of the lesson can use visual models, simulation software.

c) Some points to note in building interactive activities in the teaching process.

To organize the interactive teaching process successfully, the following conditions must be met:

- To the teachers

Firstly, the teachers should have a thorough grasp of the theoretical basis of the interactive teaching strategy. These theoretical bases will help them perform well in every stage of the teaching process: from the design of teaching to the implementation of the designs in the other course's curriculums.

Secondly, teachers need to have specific teaching models to implement this teaching strategy accurately and effectively. The teaching models must be enough details for them to do, on the other hand that models have to have

a variety of types for them to choose and combine in the actual teaching conditions, to suit the learners (in accordance with diversified learning modes of students) and appropriate for the micro-teaching environment (conditions of facilities, resources, specific situations and relationships, etc.).

Third, the teachers must know how to create interactive teaching situations, and have a thorough grasp of some skills and interactive teaching techniques. These skills help them to organize, manage and lead the students' learning activities well, that help them deal with situations and relationships in the classroom better.

- For the learners

Firstly, to learn effectively, learners must have the right learning motivation. If you study without a motive or purpose, the learning process can not be accomplished, or it is only cramming, coercion, and of course there is no good result.

Secondly, learners must know how to learn, or otherwise, they need to have the right skills and learning strategies. Specifically, learners must have skills in taking part in pedagogical interactions which they were taught by the teacher or self-organizing to gain knowledge, take form and develop the necessary skills.

Third, the learner needs to have the will to learn persistently. In general, the learning process is arduous. If they do not persist, they will be discouraged and give up soon.

- For the environment

For interactive teaching process is successful, the teaching environment must ensure the following requirements:

First, must ensure the basic requirements of facilities such as classrooms, light, sound, common teaching technologies etc...

Second, ensure other teaching resources such as programs, materials...

Third, there should be a mechanism for organization, management towards enhancing interaction in teaching of units related to teaching and training process such as schools, Department, library, IT center, etc...

Fourth, the relationship between the entities of the teaching process must be open, friendly and sociable; attitude of tolerance, generosity, support of teacher for students and among students with each other.

2.5.2.2. Stimulating cooperation between the members of the class, mobilizing experiences of students in the process of acquiring and obtaining knowledge

There are many ways to stimulate cooperation among the members of the class, and to mobilize the experience and knowledge of students. Here are a few methods that have been applied more in teaching other subjects, but can be applied effectively to interactive teaching in mathematics:

a) Group discussion

- Describe the method

The essence of this method is for students to discuss in small groups. Group discussion increases the interaction between students with each other and between students with the surrounding environment. Group discussions are widely used to help all students participate actively in the learning process, giving them the opportunity to share their knowledge, experiences and ideas to solve a problem, that relates to the lesson. Thanks to open atmosphere of the discussion, students especially shy children, become

more bold. They learn how to express their ideas, listen to criticize your ideas, and then help students to integrate into the community, giving them confidence, excitement in learning and living.

- How to proceed

Group discussions can be implemented the following steps:

- Teachers put the topic of discussion, divide into groups, give questions, ask for discussions in each group, set time for discussion and assign discussion positions of groups.

- The groups conducts the discussion.

- Representatives of each group presented the results of the group discussion. Other groups listen, ask questions, exchange, and add comments.

- The teacher summarizes the comments.

- pedagogical requirements

- There are many ways to divide the group according to the number of attendance, by color, by symbol, by gender, by sitting position,...

- The size of the group can be large or small that depends on the discussion's issue. However, groups of from 4 to 8 students are best, because they are small enough to ensure that all children can participate actively. At the same time, the quantity of these students are large enough to ensure that children are never short of ideas, and have nothing to say.

Example 7: When the teachers teach about the common trigonometric equations, the teacher can give 5 trigonometric equation, these equations have different forms, as follows:

"Find solutions for the following equations:

$$1) 5 \cos^2 x + 5 \sin x - \sin^2 x - 1 = 0$$

$$2) 3 \sin^2 x - 5 \sin x \cos x = 1$$

$$3) \sqrt{3} \sin 3x - \cos 3x = \sqrt{2}$$

$$4) \tan(2x + 1) \tan(3x - 1) = 1$$

$$5) \tan x - 2 \cot x + 1 = 0 "$$

Divide students into groups (6 to 8 students) and ask groups to discuss ways to solve trigonometric problems. It is able to combine with the use of "tablecloths technique" to ask each member of the groups to write their own ideas into the corners of the "tablecloths", and write a general idea in the center of the "tablecloths".

b) Small group activities

- Describe the method

Small group activities are similar to those discussed above for group discussion, except that the teacher wants the students to do more specific exercises than to discuss the topic.

- How to proceed

First, the students need to discuss before they do the exercises and present, introduce their product.

- Pedagogical requirements

- The contents and forms of the activities in the group must be suitable with the teaching subject, suitable with the needs and the level of students and the real conditions of the class and the school.

- The presentation, discussion of results, products of group activities can be in various forms.

Example 8: Once the teacher has taught the concept of a function, the teacher can divide the students into small groups at the table and ask the students to present the

related knowledge about the function that they have learnt, presented in the form a "thinking map". The groups will work, exchange independently at home and present in a large paper, colorful, and bring to the teacher in the next lesson. The mind map looks like as showed in Figure 2.

c) Game method

• Describe the method

The games are a way for students to learn a problem or to perform actions, attitudes, and works through a game. Through the games, the teachers will create a highly interactive environment, that always maintain the excitement and reaction of students with teachers and the environment. The students are not only developed in terms of intellectual faculties, constitution and aesthetics but also formed many positive qualities and behaviors. Therefore, the games are used as important teaching methods.

• How to proceed

There are some of ways to organize math games for students, as the following:

- *Relay game:* Divide the class into teams, the teams will have to do the exercises that are given by the teacher, then each member in the team to present in a certain time (it is able from 3 to 7 minutes), the next member will continue the presentation of the previous member in their team. After a certain period of time, the teams that do the best will be the winners.

- *The game responds to multiple-choice questions*, such as: "Conquer the challenges" or "Find the treasure", "Win the flag", Players in these games will have to answer the multiple choice questions quickly, that have been prepared on the computer, if the journey closes to the destination, the difficulties will increase. Players will lose the right to play if they miss a sentence.

- *The quiz:* The teacher splits the class into teams (maybe splits into two teams). The teams will prepare the questions themselves around a topic that teachers have set to ask the opposing teams. Questions can make preparations beforehand and sent to the teacher prior to entering the game. The teacher can adjust the questions accordingly. After the teams give questions, the opposing teams will discuss, and nominate their representatives who will present the team's ideas.

In addition, there are also other games such as "Olympia Quiz",... with the forms and rules of the game more lively. Students will have to go through many more exciting rounds such as: Start; Overcome obstacles; Acceleration; Go to destination. However, to organize this game takes the teachers a lot of time to prepare the questions system, enter these questions into the software, with a wide range of knowledge. Therefore, this game should only be held for students to participate at the end of a semester or school year.

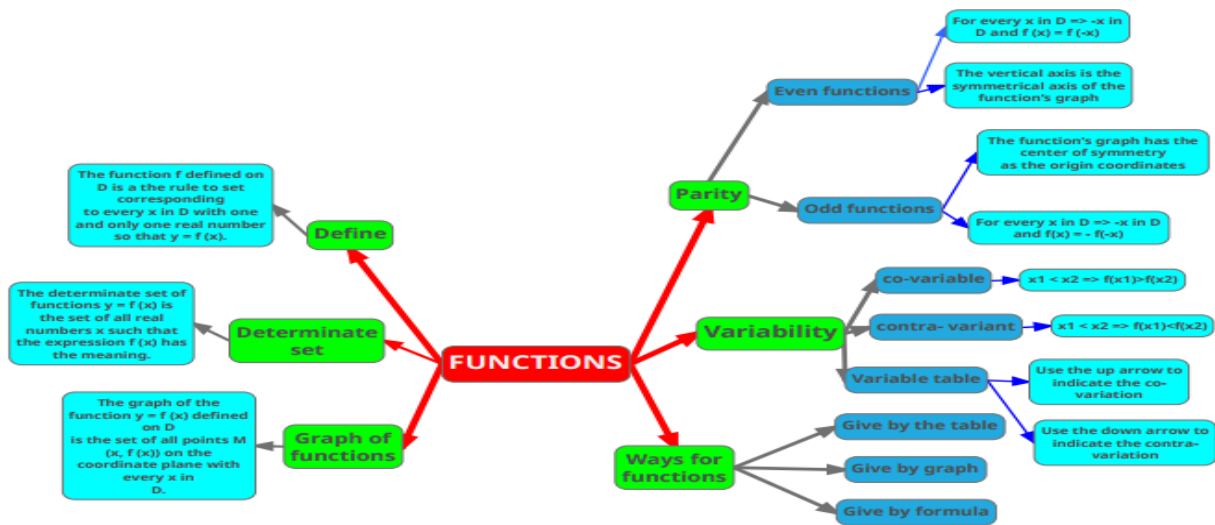


Figure 2. The Thinking map describes knowledge of functions

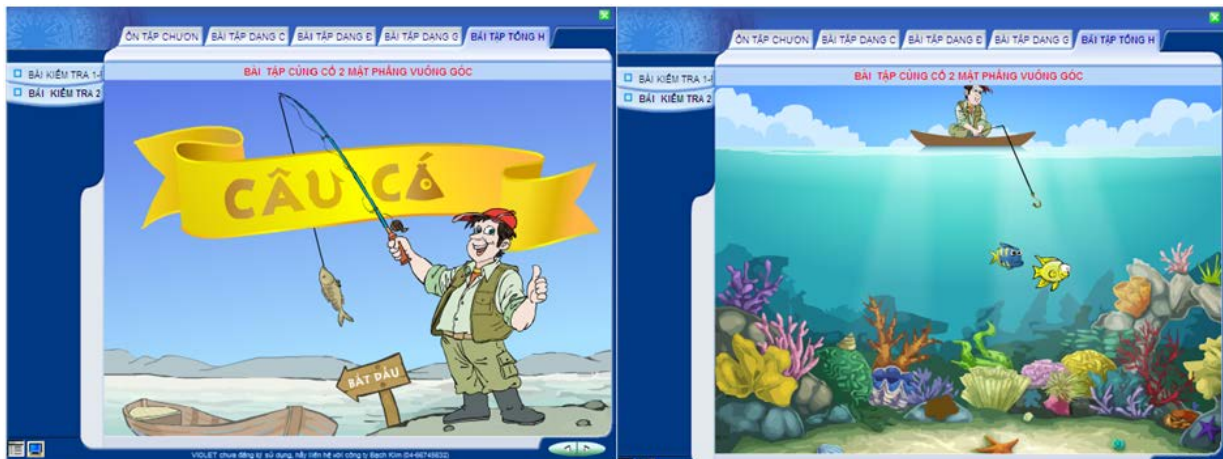


Figure 3. Use the Violet software to create "Fishing" game reinforces the knowledge

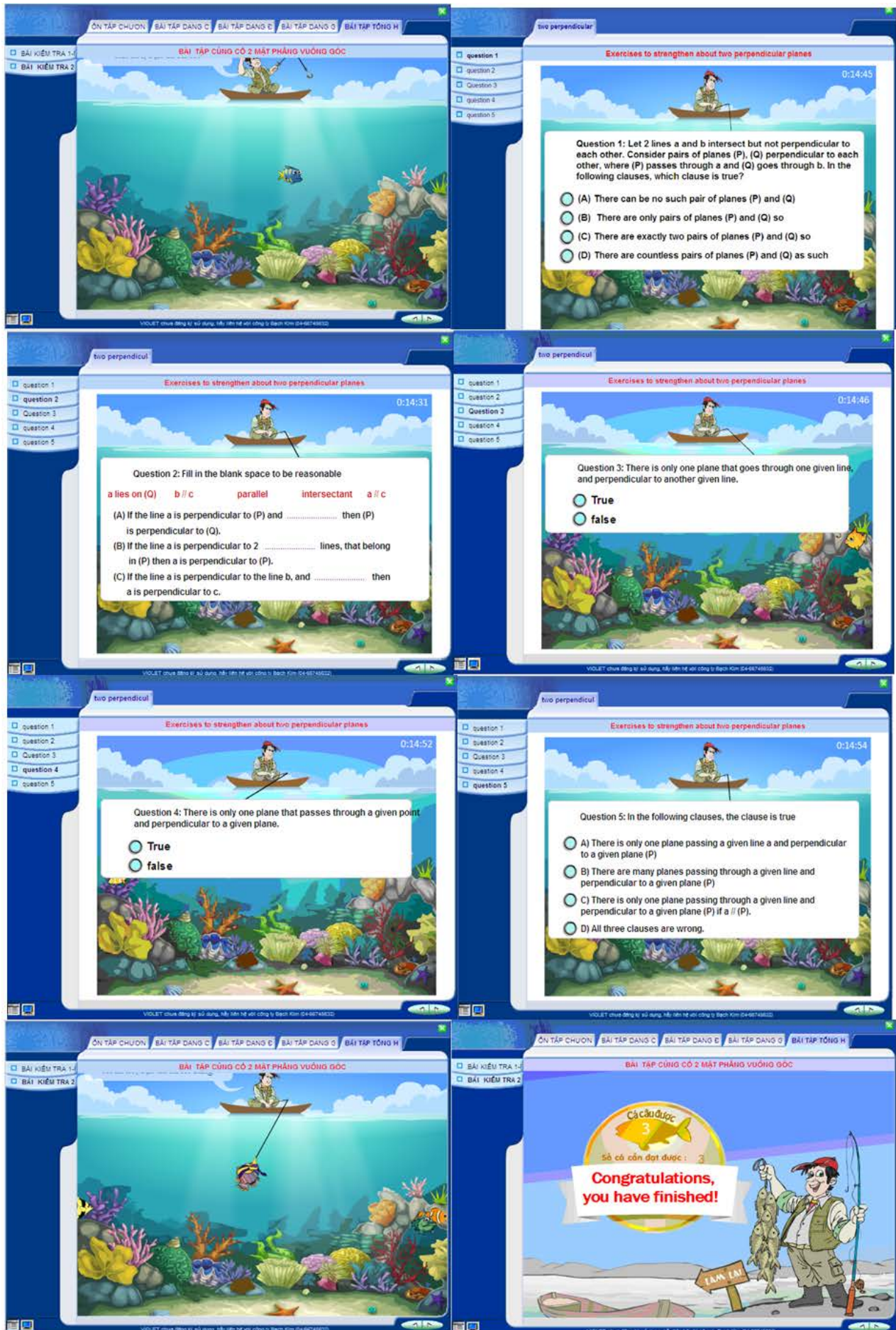


Figure 4. Use the Violet software to create "Fishing" game reinforces the knowledge

- *Pedagogical requirements*

- The game must be easy to organize and perform, it must be appropriate with the theme of education "learning to live together", with the characteristics and qualifications of students, with time funds, with real conditions of the class. Simultaneously, it must not be dangerous for students.

- Students must grasp the rules of the games and respect the rules of the games.

- The time and venue of the games must be specified.

- It must promote the activeness, initiative and creativity of students, facilitate students to participate in organizing and controlling of all stages: from preparing, conducting games and evaluating after playing.

- The game must be rotated, changed appropriately to not be boring to students.

- After the games, teachers need to let the students discuss the meaning of education of the games.

Example 9. After completing the "Two perpendicular planes", to reinforce the knowledge that the students have learnt for the students, the teacher can create an interactive environment by asking students do some multiple choice math problems through the game "Fishing". Each selected fish presents a question about the basic knowledge of two perpendicular planes. The player must answer the questions, if it is correct then the fish is caught, otherwise the fish will run away. The game will stop when there are no fish to catch. The questions and pictures are presented in Figure 3 and Figure 4.

2.2.3. Assessment Stage of Learning Outcomes

To confirm the learning results, training and standardization of knowledge of learners need to test and evaluate the learning results of learners. This helps the learner to know his or her abilities and the teacher has the necessary pedagogical adjustments. The teacher determines the contents, forms and timing of the test. This work is not just about classifying learners, but mainly helps the teachers find the basis for adjusting teaching methods. Assessment of learning outcomes helps learners to adjust their learning methods to improve the quality of teaching and learning. Therefore, testing and evaluation should be conducted regularly and systematically throughout the learning process in various forms and levels.

In the interactive teaching, apart from evaluating the learning outcomes, which implements the same as the regular evaluations (including: diagnostic evaluation, partial evaluation, summary evaluation and make a decision), Assessment stage of learning outcomes is also conducted through interaction between each student with students and with teacher. The assessment is limited not only the test's results but also the interactive skills. It is the ability to collaborate, know how to find and share information, and deal with situations in their learning groups. To assess the students' learning outcomes objectively, teachers can combine to use Information Technology, such as the use of the exercises system in the computer, that the students can do and the computers will give results immediately, so it shortens the marking time, but still has the feedback from the learners. Teachers also evaluate students through members of their group's comments on the level of integration of their bandmates, other group's comments on the work results of the group.

This assessment will create motivation and encourage students to participate in activities of the teaching process, to gain knowledge for themselves.

2.3. The Process of Implementing Lesson Plans to Apply Interactive Teaching in Mathematics at High Schools

2.3.1. The Process of Organizing Interactive Teaching in Teaching Mathematics

To perform Interactive teaching Math, in a lecture, teachers can implement the following process:

Step 1: Examine the old lesson, introduce the new one

Step 2: Create appropriate interactive situations, stimulate senses of students, encourage students to learn.

Step 3: Students perform interactive tasks, building their own knowledge through interactive situations created in step 2.

Step 4: Students report the result

Step 5: The teacher summarizes, consolidates knowledge.

2.3.2. An Illustrative Example of Interactive Teaching through the Exercises for Solving Trigonometric Equations (Algebra and Analysis 11)

This lesson plan is designed when students have completed the basic trigonometric equations, and some common trigonometric equations in the program of the Algebra and Analysis 11 [15]. This studying session works as a summary, it is for the quite good students.

1) Objectives:

Knowledge:

- + Summarize the methods of solving trigonometric equations.

- + Strengthen, correct mistakes that are easy to get when solving trigonometric equations.

Skills: Training for students to solve the trigonometric equations competently, know to identify and detect how to solve the trigonometric equations.

Attitude: + Be self-conscious, positive in learning;

- + Strongly present ideas and learn;

- + Learn how to cooperate, interact between students in the class.

2) Preparation of teachers and students

The teachers: Prepare study cards that students will do the exercises in the class; An erroneous solution presented by the PowerPoint software; a homework that was printed ready to assign to the students.

The students: assign tasks to each individual in their groups, review and solve the trigonometric equations which are learnt.

3) The process of teaching hours

Step 1: Examine the old lesson, introduce the new one

Introduction: We have learned how to solve basic and common trigonometric equations. Today, we summarize the methods of solving trigonometric equations and train the ways to find the fastest solution with each specific equation, at the same time complete the solutions of the problems.

Step 2: Create appropriate interactive situations, simulate senses of students, encourage students to learn.

- Describe the goal of the lesson as a summary of methods of solving trigonometric equations; practice the

method of detecting trigonometric equations; Correct mistakes when solving trigonometric equations.

- Divide the class into groups of 4 to 8 students (depending on the number of people of the class) and assign tasks:

The groups will emulate through 3 rounds (Round 1: Examine to find solutions of the trigonometric equations; Round 2: Examine to solve mathematics among the groups in the form of relay; Round 3: Examine to find the errors in the solution by the "tablecloths" technique). Scores of the three rounds are 100 points that is allocated in three rounds: 40-30-30.

Step 3: Students perform interactive tasks, building their own knowledge through interactive situations created in step 2

Activity 1: Practice finding methods of solving trigonometric equations through round 1 of the competition.

Teacher gives each student a study card that asks for finding solution of 10 trigonometric equations:

Study card:

Find solution of the following trigonometric equations:

1) $\cos\left(3x + \frac{\pi}{6}\right) + \sin 2x = 0$

2) $1 + \cos^3 x - \sin^3 x = \sin 2x$

3) $4\cos^3 x + 3\sqrt{2}\sin 2x = 8\cos x$

4) $\sin x = \sqrt{2}\sin 5x - \cos x$

5) $\frac{1 - \tan^2 x}{\tan 5x} = 2\sqrt{3}$

6) $\sin 4x \cdot \cos 16x = 1$

7) $4\sin^2 x - 2\sqrt{3}\tan x + 3\tan^2 x - 4\sin x + 2 = 0$

8) $\sin x + \sin 2x + \sin 3x = 0$

9) Find m so that the following equation has the solution: $\sin^2 x + \sin x \cos x + m - 1 = 0$

10) For $\triangle ABC$ satisfy the following relation:

$\pi \cot A - 4A = 0$, Find angle A?

In the above 10 equations, each equation has a different solution, teachers do not require specific solutions, but only to find solutions of those equations. Through discussions within the group, students will exchange experiences on how to solve trigonometric equations, thereby the students know how to identify trigonometric equations corresponding to each method that was studied and systematise the methods of solving trigonometric equations.

Activity 2: Examine to solve mathematics among the groups in the form of relay

The teacher gives the following problem:

Problem: Solve equation:

$$(2\sin x - 1)\tan x = \frac{2\cos x}{\sin x - 1} + \frac{3}{\cos x}$$

Requirement: Each group in turn sends each student to the board within 1 minute, the students will continue to complete the presentation of the previous students in that group. After 10 minutes, the teacher will mark presentations of the groups according to the criteria which was set. The groups can comment on other groups' presentations.

Activity 3: Examine to find the errors and correct in the solution of trigonometric equations by the "tablecloths" technique.

The teacher gives each group a "tablecloth" (possibly a large paper), which is divided into several corners depending on the number of members in each group. The teacher slideshow the solution of the following problem and ask students to find and correct the mistake in the solution:

Solve the equation:

$$2(\cos x - \sin x) - \sin x \cos x + 2 = 0$$

Solution: "Set $t = \cos x - \sin x = \sqrt{2}\sin\left(\frac{\pi}{4} - x\right)$;

condition: $|t| \leq \sqrt{2}$

We have: $t^2 = 1 - 2\sin x \cos x$

so $2\sin x \cos x = 1 - t^2 \Leftrightarrow \sin 2x = 1 - t^2$ (*)

Instead into the equations, we have:

$$2t - \frac{1-t^2}{2} + 2 = 0 \Leftrightarrow t^2 + 4t + 3 = 0. \tag{1}$$

The solution of equation (1) is: $t_1 = -1$ (satisfied) ; $t_2 = 3$ (eliminate)

Replace $t_1 = -1$ into (*), we are:

$$\sin 2x = 0 \Leftrightarrow 2x = k\pi \Leftrightarrow x = k\frac{\pi}{2}; k \in \mathbb{Z}''.$$

This is an situation that requires the students have to have critical thinking and combination multiple different thinking to have many ways of correcting the mistake. The members in each group will think and write their own comments into each corner of "Tablecloth", then discuss and write the group's comments in the middle of the "tablecloth".

Step 4: Students report the result

After each action students report the results of them previous the class.

Activity 1: The teacher asks the representatives of each group to present the solution of the 10 trigonometric equations. If the group presents exactly of solutions of all 10 equations, that group will has the maximum score as 40 points, and the groups that has wrong answers will be minused the points of that group depending on the level of error.

Activity 2: In this activity, the groups will send their representative members to present in the form of relay, with each member will present only one minute. After the groups have finished presenting the solution, the teacher asks the groups to comment on the other group's post. The score for this round is 30 points.

This activity requires the cooperation of the "fit" of the members in their group.

Activity 3: The students are interacted through the use of the "tablecloths" to write the comments of the members and the group. After handing over the "tablecloths" to the teacher for evaluation, grading, the whole class together look back at the mistakes that the solution was caught: that is the transformation to square the two sides of the equality: $t = \cos x - \sin x$

pull out: $t^2 = 1 - 2\sin x \cos x$.

This is only possible when the two sides of the equality are positive.

In this activity, to stimulate the interaction of students in groups, teachers can observe groups while the groups

are discussing, and if there is an opinion that the solution is correct, teachers can give one counter-example: Such as, if we instead $x=0$ into the above equation, it will not be satisfied, this will stimulate students to find the cause of the error. How to fix the error:

Option 1: Replace $t=-1$ on the expression

$$t = \sqrt{2} \sin\left(\frac{\pi}{4} - x\right);$$

Option 2: Still instead on the same above solution, and set condition: $\cos x - \sin x \leq 0$; because $t=-1$, so if the squares leads to the equivalent equation, the two sides of the equation must be the same sign, after finding the solutions, we must check conditions to eliminate extraneous solutions.

Option 3: Try again all of the solutions that have given. This is only possible in cases the number of points of the trigonometric radian is finite and easy to calculate right results is:

$$x_1 = \frac{\pi}{2} + k2\pi, x_2 = \pi + k2\pi (k \in \mathbb{Z})$$

Step 5: *The teacher summarizes, consolidates knowledge*

Teachers and students to solve problems and summarize the methods of solving trigonometric equations, the teacher asked the students to repeat, and summarize as follows:

Option 1: Transfer of the basic trigonometric equations;

Option 2: Transform of the form product;

Option 3: Set hidden sub.

Option 4: Evaluate the two sides (it is able to change the equation of the form: Sum of two functions $\sin x, \cos x$ is equal to ± 2 , or the product of two functions $\sin x, \cos x$ equal to ± 1 , or guess solutions and prove these solutions are unique).

Option 5: Use graphs

The teacher summarizes the emulation, comments and pull out lesson's experience, the teacher can reward the groups that won the first prize to encourage them to participate in interactive learning in the next lessons.

The teacher evaluates the learning outcomes of each student through the test on the class, and give the assessment form to each group to comment and mark to the other group; At the same time, The teacher gives the assessment form for each student to assess the interactive skills of the members in their group about the abilities of active communication and share in the group, seeking solutions, confidence and responsibility.

3. Conclusion

Interactive teaching is a teaching orientation, which is implemented via a two-way interaction between the student, the teacher and the environment. In which, the student becomes a true subjectivity of cognitive process with excitement, active participation and learning responsibility; the teacher acts as an instructor and

assistant; the environment affects the entire teaching process with the influence and adaptation. To organize interactive teaching in Mathematics at high school effectively, the teacher needs to understand stages of interactive teaching, the process of implementing the lesson plan, how to inspire the learning, how to use techniques and forms of interactive teaching organization, simultaneously combine with the exploitation of information technology application creating interactive teaching situations, in order to develop the interaction between the student, the teacher and the environment in the teaching process. Interactive teaching contributes to the promotion of the student's positiveness, activeness, creativity. However, no method of teaching is multipower. The promotion of all strengths of interactive teaching depends on the contents and objectives of teaching, facilities and equipment sufficiently to meet the minimum requirements of interactive teaching. In addition, interactive teaching should be combined with other active teaching methods so that the teaching will get effectiveness, enhance the quality of teaching at high school.

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