CHAPTER 2

A METHOD OF FORMATIVE ASSESSMENT: LEARNING TRAJECTORIES[1]

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EVALUATION IN THE LEARNING AND TEACHING PROCESS

In many studies, it has been found that the way of evaluation drives learning and that measurement assessment activities are used appropriately to improve students' level and quality (Biggs and Watkins, 1996; Black and William, 2008; Clarke, 2001; Rich, 2019). An evaluation was needed in every teaching period, and student success was tried to be measured with many tools (Basol, 2013). In this respect, it is a multi-step, systematic process that involves collecting and interpreting educational data to determine the effectiveness of evaluation, teaching, and learning (Canbazoğlu, 2008). In other words, "removing results from measurements and reaching a value judgment about measured individuals or objects" (Bol, 2002, p.5).

Howell and Nolet (2000) see the assessment as a decision-making process and keep it separate from the trial. Yilmaz (2015) defines the evaluation as a process of reaching a value judgment and from there to a decision by comparing the results of measuring it to a criterion of the same area. As can be seen from all these definitions, the assessment is; the goal can be defined as a process that allows you to determine how much has been achieved, which unreachable gains are, what student deficiencies are, and how to address these deficiencies, students to learn wrongly and how this misinformation can be corrected.

The main objectives of measuring and evaluating in education, according to Basol (2013) are:

- To determine the degree to which students have achieved the targeted gains in the process,
- In addition to the cognitive learning of students, to determine how much they have the appropriate attitudes and skills,

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- To demonstrate the success or failure of students in the result of teaching with concrete data,
- To determine the specific needs and expectations of students regarding teaching.

In order to evaluate a specific feature within the framework of these purposes, the measurement property must be expressed in a value according to the measurement results (Minister, 2019). Types of evaluations used in education; the criteria used are classified in different ways according to the purpose of use (Yasar, 2008). Evaluation according to the criteria used; absolute evaluation and relative evaluation are divided into two (Enterprise, 2009). In absolute evaluation, values expressed as both notes and percentages are considered to be the limit of proficiency, and those who reach this limit are considered successful. Since the criteria used here are predetermined critical values to reach a decision, the evaluation is also called absolute evaluation (Enterprise, 2009). In the relative evaluation, the criteria to be used to reach a decision are determined later. Since a criterion is used depending on the performance of the group and the criteria to be used according to the group's performance will vary, the assessment is called (Kilmen, 2017).

In order to determine the achievements and failures in the courses in the Turkish education system, students are given a success grade at the end of each semester. However, the evaluation is far beyond giving the student a score and grade with a figure. (Yilmaz, 2012). As a matter of fact, article 32 of the Regulation of Primary Institutions (2003, p.11) states: "In the measurement tools prepared to determine student success, it is weighted not only to measure information but also to measure the behaviors they acquire at the level of understanding, application, analysis, synthesis, and evaluation."

To identify student inadequacies and the sources of these inadequacies in education and to make decisions about the student: "Oral polls, written polls, drama, performance assignments, attitude scales, observation, self-assessment, grade scoring key, dictation, multiple-choice testing, peer evaluation, project, personal development file, rating scale, checklist, concept map, short-answer items, matching substances, accurate/false substances, read/write activities, homework, interview (interview), learning logs and composition" are recommended (Single Kebab, 2016, p.16). These evaluation methods include; written polls, oral polls, multiple-choice tests, short-answer items, matching substances, and accurate materials are treated as traditional evaluation methods, while evaluation tools such as project, performance evaluation, portfolio are treated as complementary evaluation methods (Elden, 2009). Traditional evaluation is periodical examinations conducted at regular intervals during the year to determine students' shortcomings at the beginning of the semester, period, and at the end of the semester. However, traditional evaluation methods do not provide teachers and parents with clear information about why the student has problems with development and learning. With these evaluation methods, the student's capacity and skills can often be determined (Alakurt, 2006). Finally, complimentary evaluation methods cover all methods outside traditional evaluation methods (Taylor, 2003).

Contrary to traditional evaluation, students are actively involved in the learning process besides the teacher with complementary evaluation methods, plan the teaching process together, and can be evaluated in the process, not at the end of the process. When evaluating the learning process of evaluation types, different types are divided into different types according to the purpose of use (Özçelik, 2013). The measurement and evaluation methods used in this respect are to identify students, monitor students' learning throughout the unit, and determine their level of success; they are divided into formative and level-setting assessments facing recognition and placement (Özçelik, 2013).

In the early days of school, the evaluation of the assessment to determine the pre-information for the cognitive and social, and emotional development of the child is called recognition and placement (Senemoğlu, 2012). At the end of the teaching process, the level of evaluation is called the evaluation type of which is determined by students in order to determine how much the students have earned (Semerci, 2008). Both types of evaluations are seen as not giving teachers a turn about what issues students have difficulties in the process, the reasons for their difficulties and which strategy should be proposed to which student in the face of these difficulties. Determining learning goals, evaluating where the student is according to these goals, and using effective teaching methods to close the gap between them have made the formative assessment more critical than other evaluation methods (Taşkın, 2018).

FORMATIVE ASSESSMENT

Formative evaluation is a planned process to periodically control students' understandings in educational activities (Popham, 2008; William, 2008). According to Black and William (1998, p.7), the formative assessment is "a form of activities used to provide teachers or students with the purpose of transforming teaching and learning activities.". During the education process, formative evaluations are carried out to teach students according to their individual characteristics, to identify and eliminate difficulties in the process (Minister, 2019; Basol, 2013). In other words, assessments aimed at revealing what the student knew, which did not aim to grade, are called a formative assessment (Keeley, Eberle and Farrin, 2005).

According to another definition, the formative evaluation is an interactive evaluation of student development and perception, and the reorganization of teaching accordingly by determining the needs of students (CERI, 2005). Ertürk (1982) refers to the formative evaluation as an evaluation during the instruction and a series of measures taken after this evaluation to correct the student's learning speed, inadequacies, and errors in the teaching situation. In other words, formative evaluation should provide teachers and students with the opportunity to return and correct at every stage of the teaching-learning process (Brookhart, 2008). Fisher and Frey (2007) emphasize the importance of teaching methods and providing feedback to students throughout the teaching and learning process. As all these definitions suggest, the formative assessment provides teachers and students with information about how the teaching process progresses. McManus (2008, p.3) describes the formative assessment as "a process that provides feedback to regulate teachers, students' learning activities during the course and increase students' reach at the end of the course." All these definitions result in the formatting assessment being particularly irreversible.

Cowie and Bell (1999) during the formative evaluation process; The goal has stated that there are four steps to be followed, to determine the current levels of students, to determine the steps between the students' location and the target, and to determine the activities for these steps, and to implement these activities in order for students to reach the goal. In the formative assessment, the teacher shares learning goals with students, determines which students meet which goals, identifies and implements support strategies (Harlen, 2003, p.20). Allows students to close the gap between where they are and the target. For example, if an assessment improves the quality of learning, that evaluation format should be considered successful (Lai, 2002). A process in Figure 1 is applied in the formative evaluation method.

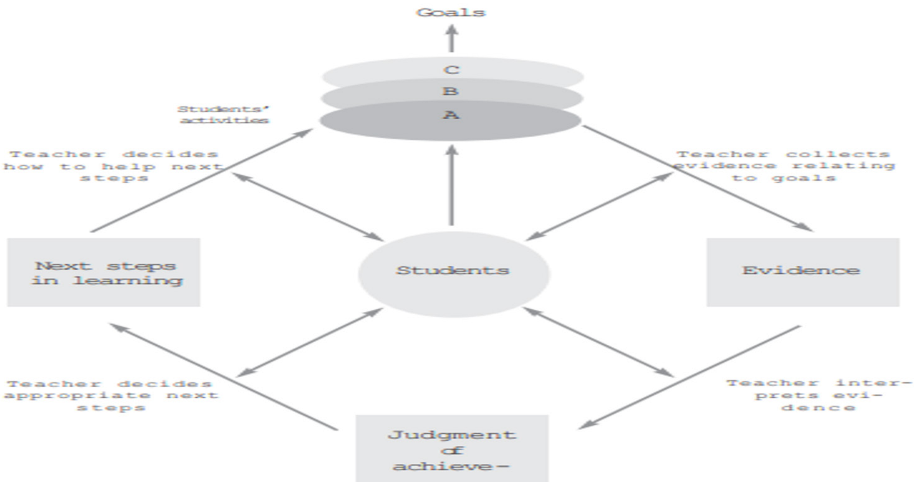

Figure 1. Formative evaluation process
Harlen, W. (2003). Enhancing Inquiry Through Formative Assessment. Exploratorium: USA

As shown in Figure 1, in the first stage, the teacher must set his learning goals and clearly specify these goals for students. So students can understand what to expect from them. The teacher then uses versatile and different evaluation methods to make how far students achieve their learning goals more straightforward. In the third stage, the teacher analyzes and interprets the data obtained as a result of the evaluation. This data gives the teacher information about how the process works. In the most recent stage, the teacher preplans the process according to the needs of the students according to the comments made and the data obtained (Harlen, 2003).

McMillan (2007) describes the formative evaluation cycle as in Figure 2. As shown in Figure 2, the returns are the most important part of the formative assessment. Because the teacher feeds on returns, helping to improve the process and improve the performance of students. Depending on the feedback given by teachers, students can understand their strengths and weaknesses so they can work harder to complete their shortcomings. In this respect, teachers should know how to set their learning goals, determine student shortcomings, and which students to return (McMillan, 2007, p.3).

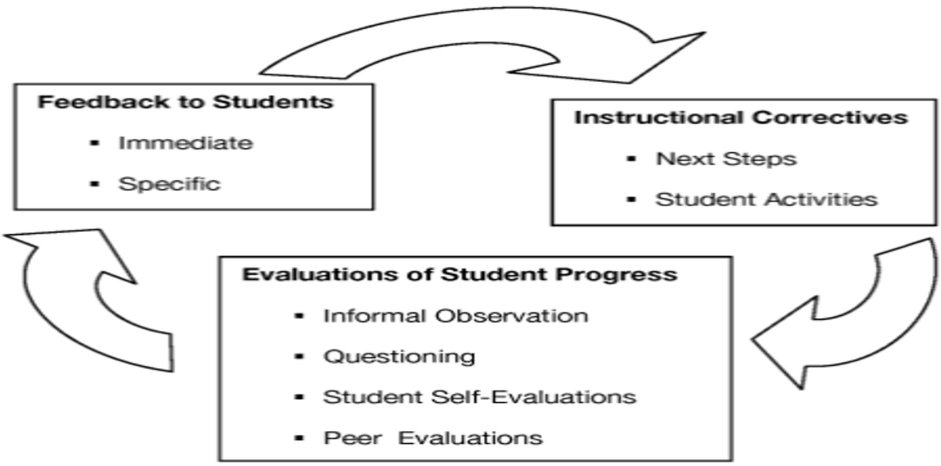

Figure 2. Formative evaluation cycle
McMillan, J.H. 2007, *Formative classroom assessment, theory ınto practice.* Teachers College Press: United States of America

According to Irons (2008), the formative assessment has a vital impact on student motivation. Because students are active participants in formative evaluation and have knowledge of what they are trying to learn and their mistakes. Thus, students can decide their own steps in the next process by seeing their strengths and weaknesses in the learning process. Formative assessment practices have a significant impact on raising the awareness of students and teachers. Because the formative assessment allows the student to realize where he is, where he should be and how he should get there. This awareness is crucial for the healthy and prosperous progress of the teaching and learning process (Irons, 2008).

Shavelson and others (2008) indicate that formative assessments have a continuity that extends from formal to informal, and for this continuity; there are three mainstays, unprepared, planned and formal and simultaneous with the curriculum. Depending on the time spent in a formative evaluation application, the quality of the data expected to be obtained and its nature, and the nature of the return given to the student by the teacher (Flood, 2018). With a formative assessment according to Yin and others (2014) students can learn about their knowledge and insights, see the steps they are expected to reach or pass to them in order to reach the goal so that students can move more accurately to the goal by reconfiguring their own information.

Elden (2019) stated that many evaluation tools are used in the formative assessment, from multiple-choice testing to performance evaluation. He also stated that the formative assessment allows them to evaluate not only teachers, but also their own development in their students. Again, the formative assessment covers not only before or after the process, but all decisions made in the teaching process. In addition, the most important feature that distinguishes the formative assessment from other types of evaluation is that it provides feedback to students. Thanks to this feedback, the teaching process is preplanned and implemented. Another thing that makes shaping evaluation important is that it encourages all students to succeed rather than compare them to each other (Black and William, 1998).

Many complementary measurement and evaluation techniques have been developed to apply the formatting evaluation according to its purpose. These techniques are used for different purposes during the teaching process. In this study, learning trajectories were mentioned as a complementary and formative method of values.

A FORMATIVE ASSESSMENT METHOD: LEARNING TRAJECTORIES

Since the 1980s, studies in teacher training have emphasized that more research should be done about their knowledge than teachers' behavior (Yıldırım, 2013). Shulman (1986) emphasized that more teachers should explain subjects, decide what the teacher will teach, how to convey it to the student, assess overall student understanding, and how students deal with misunderstandings. Shulman (1986) described the knowledge of teachers' field knowledge and the effects of this information on teaching as a loss in the field of education research. At this point, Shulman (1986) mentioned that teachers should have three types of knowledge, most generally, field knowledge, teaching program knowledge, and pedagogical field knowledge.

Shulman (1986) stated that the field knowledge is more about explaining why certain rules apply in that field, rather than knowing the knowledge, concepts and facts in the relevant field, and how these rules are in theory and practice with other rules inside and outside the field. According to Kahan, Cooper and Bethea (2003), teachers have a role in teaching the subject, and the field knowledge it has played a role in teaching the subject; However, the good knowledge of the teacher on the subject does not mean that this issue can also be taught very well.

In recent years, many researchers have focused on how a teacher has good field knowledge, as well as how he transmits his knowledge to the student (Cankoy, 2010; Gürbüz et, 2013; Hill, Rowan and Ball, 2005; Tchoshanov, 2011). In other words, the pedagogical field information levels that teachers have a very important effect on students' learning (Gökkurt, Şahin, and Soylu, 2012). The knowledge of the curriculum is defined as a teaching program prepared for a certain level of class and information to have on how to use their sources of interest (Shulman, 1986). Shulman (1986) refers to pedagogical field knowledge as the ability of the teacher to pass on the field information he has on the subject to the students. Again, according to Shulman (1986), pedagogical field knowledge is a way to teach a subject to others in the most understandable way. Pedagogical field knowledge also includes knowing what will make it easier or complex to learn certain subjects, the preliminary information that students of different ages and accumulations have on the subject to be taught, the concept misconceptions of students, and explanations about how to mislead them (Shulman, 1986).

As the above research shows, many educators have developed different models based on the information model developed by Shulman (1986); Fennema and Franke, 1992; Cochran, De Ruiter and King, 1993; Magnusson, Krajcik and Borko, 1999; Park and Oliver, 2008; Ball, Thames and Phelps, 2008; Rowland et us, 2009). One of these models is the "Mathematical Knowledge for Teaching" model developed by Ball, Thames and Phelps (2008), which aims to determine teachers' in-class behavior (Aslan Tutak and Köklü, 2016). In this context, the answer to two basic research questions was sought: a) What are the duties of teachers in the classroom in the mathematics teaching process? and b) What are the mathematical knowledge and skills necessary to perform these tasks correctly? Within the framework of these questions, Ball, Thames and Phelps (2008) developed various scales and measuring tools. One of these tools, the learning trajectory, is one of the main focuses of this research.

Where should we start teaching math? What aspects of mathematics are more important? How can we determine what a student knows? How do we identify students' shortcomings and address it? Friedrichsen and Dana (2005) say learning trajectories are an important tool where we can answer questions like the one above. According to Clements and Sarama (2014), children learn to crawl first, then walk, then run, then jump in development. Mathematical ideas and skills in children progress just as they developed. When teachers understand this development and sort their activities according to this development, they create realistic mathematical learning environments.

Learning trajectories represent the gap between where children are located and the target. Therefore, teachers should consider this gap when planning lessons or editing mathematical activities. Learning trajectories are the default ways of thinking that children pass through the learning process. Learning trajectories based on studies on how students learn and think also help understand how student thinking processes change over time (Donovan, 2019). The success cycle given in Figure 3 includes testing student knowledge, teacher knowledge and an estimated learning roadmap for learning trajectory (Simon, 1995, p.136).

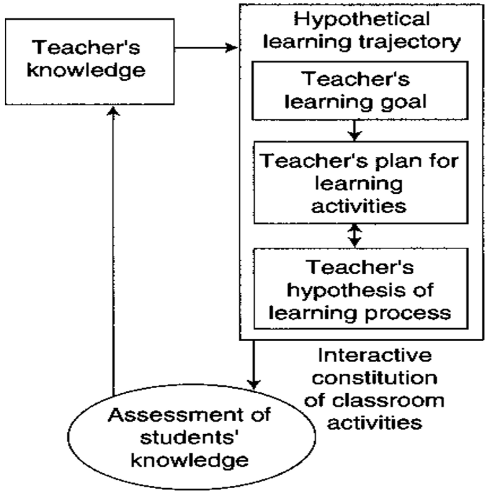

Figure 3. The math Simon (1995, p.136) describes is the cycle of success.

Reconstructing Mathematics Pedagogy from a Constructivist Perspective, Journal for Research in Mathematics Education, 26 (2), 114-145

Learning trajectory is expressed in different ways in the literature. Simon (1995) used the concept of hypothetical learning trajectory, Brown and Campione (1996), while using the term "developmental corridor," Clements and Sarama (2004). Smith and Stein (1998) described the learning trajectory as high-level tasks that enable students to interact with the concepts they will learn, increasing their capacity for reasoning and problem solving (Donovan, 2019).

Simon (1995, p.135), who first introduced the concept of learning trajectory, used the expression of hypothetical learning trajectories and stated that the basis of orbits was based on a configurative approach.

"Learning trajectories provide a vision of how students' progress in an issue. In fact, this is a hypothetical event, because no one knows the real learning trajectory. It only refers to a typical situation. Although students' learning is similar, each student's trajectory moves in a unique way. However, in normal classroom activities, teachers perform the same activities for all students."

Simon's (1995) hypothetical learning trajectory consists of three components (Figure 4). First, hypothetical learning processes containing these components; a target that determines the direction of learning (Bowman et al. 2001; Clements, 2004; Fuson, 2004; Tibbals, 2000; Weiss, 2002), focuses on learning activities developed to help children achieve this goal, and how these learning activities will improve students' thoughts and understandings (Clements and Sarama, 2009).

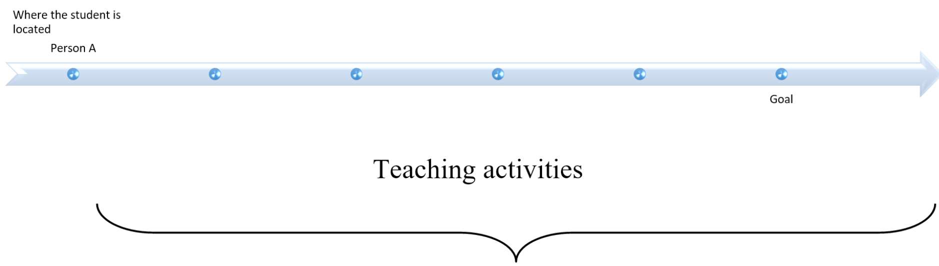

Figure 4. Simon's learning trajectory example

Understanding learning trajectories correctly and using them in a successful way is not only knowing every combination, but rather understanding how these combinations work together (Clements and Sarama, 2014). Simon (1995) said that while students were moving towards the goal at the start point, it was possible for students to see how "the teaching continues as a result." According to Simon (1995), the important things about this approach are that we're going to have to do with this approach. The design and implementation of the teaching is the centralization of the student thinking and understanding. The understanding of the student thinking is a continuous process in collecting data and producing the assumption. The academic knowledge is equal development with the teacher's knowledge (2000). For this reason, students should try to see the situation from the perspective of the child by interpreting what the child is doing and what it is thinking (Sarama and Clements, 2009).

Battista, Smith, Wiser, Anderson, and Krajcik (2006, p.5) refer to the elemental orbit as "a series of ideas in the student's teaching process." According to Battista (2004), students must first know the basic mathematical concepts in order to create a course of study, and then understand how these basic concepts need to be used on this orbit in order to understand the thinking of children.

According to Sarama and Clements (2009, p.19), the element trajectory is "a mathematical goal, a path of study that students move along their level and a teaching tool that will help them move along the way." The element allotment can also be recognized as a way to achieve specific goals in a mathematical field, including a series of teaching tasks designed to expose children's thinking, mental processes or actions (Simon, 1995). In these descriptions, the trajectory of teaching as a partner is expressed as a way for students to grow and change a mathematical subject in their grasp. Not only does the student's trajectory swell at different levels, but also demonstrate more understandable tasks that encourage progress (Wickstrom, 2014). Indeed, Clements and Sarama (2009, p.83) said: "To open up the extent and teaching of the child in a particular field of mathematics, it has been developed to demonstrate the mental processes and levels of thought of students with a series of pre-designed tasks that have been pre-designed and to support the child's reach to certain goals."

Confrey and others (2009) used conceptual trajectory and conceptual corridor concepts for the element alleged and noted key combinations representing these concepts:

- Although each student's elemental trajectory is different from each other, in fact, each student passes through the same important points in the process of teaching.
- Students are thought to be able to meet certain obstacles as they move over orbit, and therefore students should plan the teaching process more separately.
- Students' progress should be flexible in orbit and different students should be allowed to move on different paths.

Teaching trajectories can be used as a tool to help students formally change the thought of the student (Ball, Thames and Phelps, 2008). Students can change both the knowledge and the teaching program through the element trajectory. Thanks to their teaching trajectory, students can scientifically model the structure in their minds (Clements and Sarama, 2004). Researchers argue that learning trajectories are making progress to students, thus gaining higher levels of mantling execution (Ball, Thames and Phelps, 2008; Clements and Sarama, 2004; Wickstrom, 2014).

Sztajn and others (2012) are some of the studies related to the theory of trajectory and the theory of Shulman's (1987) pedagogical content knowledge and the interchange knowledge. Sztajn and others (2012) focused on how the element trajectories promote teaching and how the teaching names are determined while encouraged to learn. Shulman (1987) focuses on how the elemental orbits can help students. Researchers are trying to identify applications such as adapting to different levels of the range, making discussions easier, and analyzing tasks, such as formally changing the thinking of students.

Alonzo and others (2012) said that changes to the element algebra trajectory have different goals than traditional evaluation methods, and that they can be used to assess a group or a person. Again Furtak and Heredia (2016) referred to the elements of the element allotment; consulting student ideas, designing activities in the process of teaching, practicing activities, applying activities, and reporting application results.

Zembat (2016, p.510) stated that the element trajectory consists of three main compositions in which the element is in a decision-making. They are:

- "Target/purpose of student student's education
- Events/plan to support/develop my education
- Hypotheses as to how the education process will take place."

Zembat (2016) means that an element about the element allotment should determine an element altogether in the first period. In order to determine the teaching goal, the teacher must have the knowledge of what is mathematically in the background of the subject that the teacher will learn. In other ways, the teacher must consider the proficiency levels and pre-information of the students in the class when setting the teacher's teacher's goal. According to Zembat (2016), activities must be created to support and develop students within a teacher's plan after the target is set. These activities are hypotheses that are based on how the teaching will take place. When the teacher designs the course, the students should also have hypotheticals about the subjects they want to learn in the course and the difficulties they may face during the course of the study. The more the amount of these hypotheses that the teacher is set up, the greater the efficiency received from the course. During the learning process, the student should refer students to deep thinking and provide information about concepts. The student must rearrange the element trajectory by evaluating the student information at the end of the process. This cycle continues until all students reach the target.

Furtak and Heredia (2016) revised the names it set for the element allotment in 2012; it opens with four names: targeting and discerning student ideas, designing and reviewing tools, decision-making and data collection, reflecting, and reporting subsequent names. It benefits from student programs, standard documents, and annual/weekly plans to identify targets and reduce student ideas. As a first step, a tool is developed to reveal the existing knowledge of the students. Students may be asked to open the solution by asking a question first. It then groups the students according to the inverses they have given, developing different activities for different sides. In decision-making and data collection name, students put these activities in order. After the activities are performed, the teacher collects the information that shows how many activities work with various methods. The teacher may reschedule the process as part of the returns in the latest period.

This study was conducted based on the course of the element altogether developed by Ball, Thames, and Phelps (2008) and consisting of six steps. The learning trajectory is made up of six steps (Ball, Thames and Phelps, 2008, p.403)

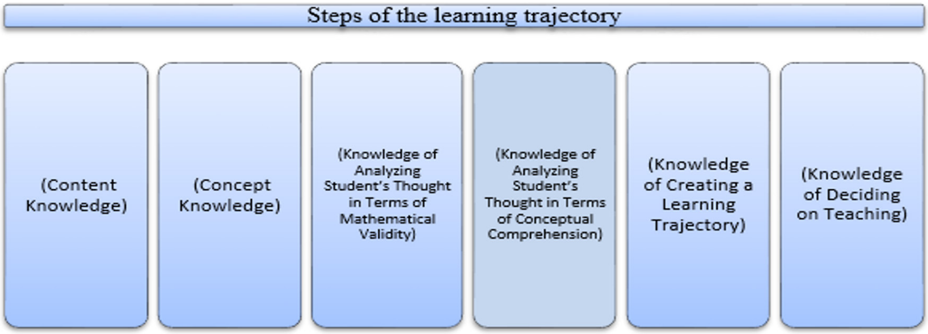

Figure 5. These digits are currently opened separately.

Content knowledge: Simon (1995) considered the content knowledge that the teacher had to be the most important part of the mathematics education cycle. Again, many educators (Ball, 1990a; Carpenter, Fennema and Franke, 1992; Ma, 1999) requires students to have a deep content knowledge so that they can learn mathematics. Although many studies have known what the rules and methods of the candidates of the teacher and teacher are and how to apply, it is observed that the underlying understanding of the given situations does not know the appropriate mathematical openings (Toluk Uçar, 2011). For this reason, Ball (1991) emphasized that teaching should have both knowledge of mathematics and knowledge about mathematics. The level of understanding of the mathematics of the critical element of this type of information (Ball, 1990a).

Ball, Thames and Phelps (2008) have developed content information in the model; common content information, comprehensive content information, customized content information, content and student information, content and teaching information, content and student program information (Kutlu, 2018). A teacher within the scope of common content information should be able to solve a math problem properly. He should also know how he should discuss the issue in his class, what methods and techniques he should explain. Within the scope of the content information that has been customized, you should be able to ask questions appropriate to the subject and examine the answers from students in a manner that is correct and rational. Comprehensive content information is information that an element must have on the relationship between the topics involved in the teaching program. The knowledge of the description of the English and the student is the information that the student can attract the attention of the student with what activities. The knowledge of natural and learning is that the learning knows the advantages and disadvantages that different methods and techniques will provide. Finally, content and teaching program information is the knowledge of the teacher to determine and describe the strategy that is most appropriate when describing the topic (Kutlu, 2018). On the other hand, Fernandez (2005) stated that students who want to put their students into useful and rich discussion environments should be informed about it as a priority. Again, it is not possible that a teacher who does not have sufficient control over the subject he will learn helps students learn.

A teacher with good knowledge of rica can solve mathematical problems in a way that is correct. It can explain what is mentioned in the question and what is desired to children, determine which win is the problem (Ball, Thames and Phelps, 2008). He can also design a subject-specific course. The selection and language use of the teacher's purpose for the course can also be evaluated in this context (Aslan Tutak and Köklü, 2016). Zembat (2016) stated that designing a teacher's educational activities based on the preliminary information of students and predicting the challenges that students are living and redesigning the course trajectory is due to the content knowledge that the teacher has. The content knowledge that the teacher has always stands as a driving force in this process and is the most important element in determining the hypotheses of learning.

Concept Knowledge: Being a math teacher is based on understanding mathematical concepts and knowing how these concepts are taught and taught with what strategies (Ball, Thames and Phelps, 2008). In this context, students should be able to express the idea and subconceptions that a particular math problem contains in order to value the understandings of their students (Zembat, 2016). In order for students to create correct representations from a conceptual perspective, he must first understand these concepts or processes at a conceptual level (McDiarmid, Ball and Anderson, 1989; Borko et. 1992; Ma, 1999). Kinach (2002a, p.5) refers to concept knowledge as "knowledge and experience in general thinking that will direct, identify and limit the ability to study and research in mathematics". In this context, students can use mathematical terms and terminology in a manner that is included in this information (Ball, Thames and Phelps, 2008). Again, students should be able to determine their strategies by considering the educational technologies that are developing while preparing their courses. The selection of appropriate technological materials for specific subjects is also important in this context (Aslan Tutak and Köklü, 2016). Baki and Kartal (2004) likened the concept knowledge to each other-connected chain rings, stating that the information gained when the link is established between the rings will increase and that the information rings will expand. Shulman (1986) has been included in the knowledge of the concept in the pedagogical field and this information is included in the knowledge of the concept; in order to be understood by the students, the teacher knows the concepts and the most appropriate strategies on the subject. Kutlu (2018) stated that the effect of the method and technology used by the teacher will vary according to the subject, the interests and needs of the students, and the goals that must be achieved at the end of the course. Therefore, a teacher should be able to identify and use the methods and techniques that students learn better (Ball, Thames and Phelps, 2008).

Knowledge of Analyzing Student's Thought in Terms of Mathematical Validity: Shulman (1986) has been included in the knowledge of the student's knowledge of the pedagogical field and this information; students with different ages and experiences have known that the preinformation, forks, concept reflects, difficulty are in the way they are aware of what is happening (Kutlu, 2018). Even and Tirosh (1995) were not recognized in the way that students with different ages and experiences were aware of the pre-knowledge and information they had about the subject. According to Wilson and others (2015), students need to know what their teacher is thinking in order to make a student-based student.' Again, when a student makes a evaluation to the student, the student must understand the logic and mathematical validity of the strategy he uses to solve the question. Because a person who is studying mathematics also needs to understand that the different answers of the students are mathematically valid (Aslan Tutak and Köklü, 2016). This information is included in the ability to identify non-standard methods used by students and to understand whether these methods are mathematically correct, and then whether they can be used in any situation (Proposal, 2010). Students should be able to determine how students can think, what they can find in a complex way. When working on any subject, they should be able to realize what they can think, what methods they can follow, and whether they will be forced. In this context, an inadequate student will not be able to mathematically change the different answers given by students, but will only describe the answers from students as right and wrong (Aslan Tutak and Köklü, 2016).

Knowledge of Analyzing Student's Thought in Terms of Conceptual Comprehension: Many educators (Cochran, de Ruiter and King, 1993; Fernandez Balboa and Stiehl, 1995; Grosman, 1990; Koballa, Graber, Coleman and Kemp, 1999; Magnusson, Krajcik and Borko, 1999; Marks, 1990; Shulman, 1987; Veal and MaKinster, 1999) were treated as a component of PAB in the model developed. Friedrichsen and others (2007) analyze the student; he described the concept that a teacher brought to the teaching environment as knowing what the misconceptions and difficulty they were. Teachers should be able to determine the conceptual understanding or student misunderstandings that exist in student studies, understand the places that the student understands incomplete, and often remove it from the student's testimony (Even and Tirosh, 1995). The teacher's knowledge of student concept misconceptions and is the basis of his knowledge of the students. Ball, Thames and Phelps (2008) said that a knowledgeable teacher on the mathematical thinking of students could explain why the concept misconception stumbles as well as finding the student's concept misconception. It is important that teachers can identify concept misconceptions and errors they have in order to support them when understanding mathematical concepts and skills (Bamberger, Oberdorf and Schultz Ferrell, 2010, p.164). Goldsmith, Doerr and Lewis (2014) examined 106 articles on the professional learning of math teachers and said that teachers who took their students' thoughts into these studies were better.

KNOWLEDGE OF CREATING A LEARNING TRAJECTORY

According to Wilson and others (2015), students' thoughts become more complex as subjects increase, and learning trajectories are of great importance to mapping student thinking. This mapping event contains assumptions about how student learning progressed. Daro and others (2011) have a consensus that learning trajectories are one of the most effective ways to demonstrate student thinking, even though everyone's learning trajectory is different. According to Ball, Thames and Phelps (2008), a teacher must adjust this strategy through a learning trajectory after analyzing the strategy the student uses to solve a math problem. Therefore, teachers should understand what developmental progress is like for a specific concept of mathematics and where to place students in this continucy. In this way, teachers' ability to use the learning trajectory is evaluated. Wilson (2009) found that teachers with good knowledge of creating a learning trajectory had better skills to identify students' abilities, understand students' mathematical thinking, and evaluate students. Wickstrom and others (2012) also said that teachers who can use the learning trajectory are better at identifying, planning and interpreting student actions. In the Edgington (2012) study, he stated that teachers with good knowledge of learning trajectory have taken more successful steps to recommend individual strategy to students and to determine learning and teaching activities so that students can achieve the goal. Again, there is important evidence that creating a learning trajectory increases the student's success and teacher knowledge (Barton, McCully and Marks, 2004). Stein, Engle, Smith and Hughes (2008) are good at ranking students on the learning trajectory, seeing teachers' student ideas as a whole, transferring important and valuable ideas as a whole to the classroom, and providing class dysplinin. Because teachers can direct class discussions according to these ideas.

KNOWLEDGE OF DECIDING ON TEACHING

The problem is that teachers should be able to offer a student-appropriate teaching model to eliminate concept misconceptions of students and get the student closer to the goal (Ball, Thames and Phelps, 2008). However, this is not an easy process. While most teachers are incapable of proposing individual strategy to students, some teachers find it difficult to explain their student responses because they find it complex (Wilson, 2009). Making mistakes according to Önal (2008) is part of learning. It would be appropriate for the spirit of configuration to see errors as an opportunity to get to the truth. Errors are an opportunity for learning, and these opportunities become permanent when not evaluated by the teacher. Teachers, on the other hand, should be able to reorganize their teaching activities so that students do not make mistakes again (Ball, Thames and Phelps, 2008). Teachers should know where students will have difficulties based on their experience and take these points into account when planning their teaching activities (Wilson, 2009).

REFERENCES

Alakurt, T. (2006). *Puanlama yönergesine dayalı değerlendirme ve geleneksel değerlendirme açısından ilköğretim öğrencilerinin bilgisayar dersi başarılarının karşılaştırılması*, Yayımlanmamış yüksek lisans tezi, Anadolu Üniversitesi Eğitim Bilimleri Enstitüsü.

Aslan Tutak, F. & Köklü, O. (2016). Öğretmek için matematik bilgisi. Erhan Bingölbali, Selahattin Arslan, İsmail Özgür Zembat (Editörler). *Matematik Eğitiminde Teoriler* (syf.712-716). Ankara: Pegem

Atılgan, H. (2009). Değerlendirme ve not verme. H. Atılgan (Editör). *Eğitimde ölçme ve değerlendirme (350-395*). Ankara: Anı

Bakan, Ü. (2019). *Biçimlendirici değerlendirme uygulamalarıyla zenginleştirilmiş etkileşimli kısa tarihsel hikâyelerin öğrencilerin bilimin doğası anlayışlarına etkisi*. Yüksek Lisans Tezi. Sivas Cumhuriyet Üniversitesi Eğitim Bilimleri Enstitüsü, Sivas.

Ball, D. L., Thames, M. H. & Phelps, G. (2008). Content knowledge for teaching: Whatmakes it special? *Journal of Teacher Education*, 59(5), 389-407

Başol, G. (2013). *Eğitimde Ölçme ve Değerlendirme*. Ankara: Pegem Akademi

Bekar Kebapçı, Ç. (2016). *Türkçe öğretmenlerinin ölçme değerlendirme araçlarını kullanma ve önemseme düzeylerine yönelik bir değerlendirme*. Yüksek lisans tezi. Dokuz Eylül Üniversitesi Eğitim Bilimleri Enstitüsü. İzmir.

Biggs, J. B. & Watkins, D. (1996). *Classroom learning: educational psychology for the asian teacher*. New York: Prentice Hall

Black, P. &Wiliam, D. (1998). Assessment and classroom learning. Assessment in Education: Principles. *Policy ve Practice*, 5(1), 7–75.

Bol, D.J. (2002). *The use of alternative assessment in physical education clasrooms*. Doktora dissertation, Kinesiology and Health Promotion, faculty of California State University

Brookhart, M. S. (2008). *Successful students formative and summative uses of assessment ınformation, assessment in education: principles*. Policy & Practice, 8(2).

Brown, A. L. & Campione, J. C. (1996). Psychological the oryand the design of innovative learning environments: On procedures, principles and systems. In L. Schauble & R. Glaser (Eds.). *Innovations in learning: New environments for education (pp. 289-325*). Mahwah, NJ: Erlbaum

Canbazoğlu, S. (2008). *Fen bilgisi öğretmen adaylarının maddenin tanecikli yapısı ünitesine ilişkin pedagojik alan bilgilerinin değerlendirilmesi*. Yüksek lisans tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara

Cankoy, O. (2010). Mathematics teachers' topic-specific pedagogical content knowledge in the context of teaching a 0, 0! and a ÷ 0. *Educational Sciences: Theory & Practice,* 10(2), 749-769.

CERI. (2005). *Formative assessment: Improving learning in secondary classrooms*. Paris: OECD

Clarke S. (2001). *Unlocking formative assessment: practical strategies for enhancing pupils learning in the primary classroom*. London: Hodder & Stoughton Educational

Clements, D. & Sarama, J. (2014). Learning trajectories: Foundations for effective, researchbased education. In A. P. Maloney, J. Confrey, & K. H. Nguyen (Eds.), *Learning over time: Learning trajectories in mathematics education (pp.1–30)*. Charlotte, NC: Information Age

Cochran, K. F. DeRuiter, J. A. & King, R. A. (1993). Pedagogical content knowing: An integrative model for teacher preparation. *Journal of Teacher Education*, 44, 263-272.

Cowie, B. & Bell, B. (1999). A Model of Formative Assessment in Science Education. *Assessment in Education*, 6, 101-116.

Donovan, J. L. (2019). An examinatıon of preservice teachers' use of learning trajectories to guıde instruction. Doktora dissertation. Submitted to the Graduate School of Wayne State University Detroit, Michigan

Elden, A. (2019). Okul öncesi öğretmenlerinin biçimlendirici değerlendirme uygulamaları. Yüksek lisans tezi. Başkent Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara

Ertürk, S. (1982). *Eğitimde program geliştirme (4.baskı).* Ankara: Yelkentepe.

Fennema, E. & Franke, M. L. (1992). Teachers' knowledge and its impact. In D.A. Grouws (Ed.), *Handbook of Research on Mathematics Teaching and Learning (pp. 147-164*). New York: Macmillan

Fisher, D. & Frey, N. (2007). *Checking for understanding, formative assessment techniques for your classroom.* ASCD Publication: United States of America

Friedrichsen, P. M. & Dana, T. M. (2005). Substantive level theory of highly regarded secondary biology teachers' science teaching orientations. *JRST,* 42(2), 218-244

Gökkurt, B. & Soylu, Y. (2016). Ortaokul matematik öğretmenlerinin pedagojik alan bilgilerinin incelenmesi: Koni örneği. *İlköğretim Online*, 15(3), 946-973

Gürbüz, R., Erdem, E. & Gülburnu, M. (2013). Sınıf öğretmenlerinin matematik yeterliklerini etkileyen faktörlerin incelenmesi. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi (KEFAD*), 14(2), 255-272

Grossman, P. L. (1990). *The making of a teacher: Teacher knowledge and teacher education*. New York: Teachers College

Harlen, W. (2003). Enhancing inquiry through formative assessment. Exploratorium: USA

Hill, H. C. Rowan, B. & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal*, 42(2), 371–406.

Howell, K. W. & Nolet, V. (2000). *Curriculum – basedevaluation: teaching and decision making*. Belmont, California: Wadsworth

Irons, A. (2008), *Enhancing Learning Through Formative Assessment and Feedback*, Routledge: U.S.A and Canada

Kahan, J., Cooper, D. & Bethea, K. (2003). The role of mathematics teachers' content knowledge in their teaching: A framework for research applied to a study of student teachers. *Journal of Mathematics Teacher Education*, 6, 223-252

Keeley, P., Eberle, F. & Farrin, L. (2005). *Uncovering student ıdeas in science, formative assessment probes.* California: Corwin ve NSTA.

Kilmen, S. (2017). Ölçme ve değerlendirmede temel kavramlar. R. N. Demirtaşlı (Editör). *Eğitimde ölçme ve değerlendirme (25-55)*. Ankara: Anı

Lai, E. (2002), *Formative assessment and quality teaching and learning*. Student Assessment and Feedback, 3, 4-7

Magnusson, S., Krajcik, J. & Borko, H. (1999). Nature, sources, and development of PCK for science teaching. In J. Gess-Newsome & N.G. *Lederman (Eds.) Examining PCK: The construct and its implications for science education (pp.95-120)*. Boston: Kluwer Academic

Council for Chief State
ations/details.cfm?PublicationsID=362

McManus, S. (2008). *Attributes of effective formative assessment*. Washington, DC: Council for Chief State School Officers.

McMillan, J.H. (2007). Formative classroom assessment, theory ınto practice. Teachers College Press: United States of America

Millî Eğitim Bakanlığı (MEB) (2013a). *Ortaokul matematik dersi (5, 6, 7 ve 8. sınıflar) öğretim programı.* Ankara: MEB

Özçelik, D. A. (2013). *Okullarda ölçme ve değerlendirme* (2. baskı). Ankara: Pegem

Park, S. & Oliver, J. S. (2008). Revisiting the conceptualisation of pedagogical content knowledge (PCK): PCK as a conceptual tool to understand teachers as professionals. *Research in Science Education,* 38(3), 261-284

Popham, W. J. (2008). *Transformative assessment*. Alexandria, VA: Association for Supervision and Curriculum Development

Rowland, T., Turner, F., Thwaites, A. & Huckstep, P. (2009). *Developing primary mathematics teaching: reflecting on practice with the knowledge quartet.* London: Sage

Semerci, Ç. (2008). Eğitimde ölçme ve değerlendirme. E. Karip (Editör). *Ölçme ve değerlendirme* (1-15). Ankara: Pegem

Senemoğlu, N. (2012). *Gelişim öğrenme ve öğretim*. Ankara: Pegem

Shavelson, R. J., Yin, Y., Furtak, E. M., Ruiz-Primo, M. A., Ayala, C. C., Young, D. B. & Pottenger, F. (2008). On the role and impact of formative assessment on science inquiry teaching and learning. In J. Coffey, R. Douglas, & C. Stern (Eds.). *Science assessment: Research and practical approaches.* Washington, DC: National Science Teachers Association, 21–36

Shulman L. S. (1986). Paradigms and research programs in the study of teaching: a contemporary perspective. In M, Wittrock (Ed.), Handbook of Research on Teaching. NY: Macmillian.

Shulman, L.S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57(1), 1-23.

Simon, M. A. (1995). Reconstructing mathematics pedagogy from a constructivist perspective. *Journal for Research in Mathematics Education,* 26(2). 114-145.

Smith, M. S. & Stein, M. K. (1998). Selecting and creating mathematical tasks: From research to practice. *Mathematics Teaching in the Middle School*, 3(5), 344-50

Taşkın, N. R. (2018). *Biçimlendirici değerlendirme tasarlama etkinliklerinin biyoloji öğretmen adaylarının modern genetik öğrenme progresyonu temelli alan bilgilerine ve pedagojik alan bilgilerine etkisi*. Doktora tezi. Balıkesir Üniversitesi Fen Bilimleri Enstitüsü, Balıkesir

Taylor, R. L. (2003). *Assessment exceptional students: Educational and psychological procedures (6 th Ed)*. Pearson Education, Inc.

Tchoshanov, M. A. (2011). Relationship between teacher knowledge of concepts and connections, teaching practice, and student achievement in middle grades mathematics. *Educational Studies in Mathematics*, 76, 141-164.

William, D. (2008). Changing clasroom practice. *Educational Leadership*, 65(4), 36-41

Yaşar, M. (2008). Eğitimde ölçme ve değerlendirmenin önemi. S. Tekindal (Editör). *Eğitimde ölçme ve değerlendirme (1-8)*. Ankara: Pegem

Yılmaz, Z. (2015). *Öğrenme rotaları temelli öğretimin sınıf öğretmen adaylarının matematiksel alan ve öğrenci bilgilerini yeniden yapılandırılmasında kullanımı*. Doktora tezi. Ortadoğu Teknik Üniversitesi Sosyal Bilimler Enstitüsü. Ankara

Yıldırım, A. (2013). Türkiye'de öğretmen eğitimi araştırmaları: Yönelimler, sorunlar ve öncelikli alanlar. *Eğitim ve Bilim*.38 (169). 175-191

Yin, Y., Tomita, M.K. & Shavelson, R. J. (2014) Using formal embedded formative assessments aligned with a short-term learning progression to promote conceptual change and achievement in science, *International Journal of Science Education*, 36(4), 531-552

Zengin, S. (2019). *Matematiksel modelleme etkinliklerinin ders içi uygulamalarının değerlendirme türleri bağlamında incelenmesi*. Yüksek lisans tezi. Marmara Üniversitesi Eğitim Bilimleri Enstitüsü. İstanbul