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LEARNING AND TEACHING

Theories, Approaches and Models

Editors: Zeki Kaya, Ahmet Selçuk Akdemir

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ÇÖZÜM
Eğitim Kurumları



Çözüm Eğitim Yayıncılık, Ankara- Türkiye

2016

LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

Editors: Zeki Kaya, Ahmet Selçuk Akdemir

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Çözüm Eğitim Yayıncılık. Ankara, Türkiye, 2016

FOREWORD

Learning is one of the most long-running, undeniably important actions of human being. In addition to his innate behaviours, acquiring new knowledge, skills and attitudes through the experiences over various processes, human being directs his life in accordance with his learning. The acquirements have an efficient role on all his decisions during the lifetime.

The meaning of learning, the processes through which it occurs, the factors affecting it in negative and positive ways are among primary questions to be answered for those scientists studying in the field. Solving the mysteries of all these questions may result in using the sources in the right way as well as contributing to the discovery of expected results. On the other hand, the answers to these questions have crucial role for also the concept of teaching, which can also be named as the direction of learning process enabling the realization of learning goals. Success of a teaching activity is primarily possible if it includes activities suitable for the basics and nature of learning process. In the historical course, the answer given to abovementioned questions caused the appearance of theoretical structures such as various philosophies, theories, approaches and models. As consistent lodestars such as principles, methods, techniques, tactics, styles and strategies, the findings obtained from the scientific studies in the field have been presented to the use of learners and teaching professionals with the purpose of guiding the practitioners.

New editions of this book are expected to develop in accordance with suggestions of its readers and our colleagues.

Prof. Dr. Zeki Kaya
Co- Editor

FOREWORD FOR ENGLISH EDITION

“Learning is expensive, yet ignorance costs more.”

Learning and teaching, two most arduous experiences of human being, are considered to have exceptional natures as well. Many scholars have tried long to explain the phenomena during which we ‘learn’ and ‘teach’.

This book is a great contribution to its field in that it gives the basics in context with typical processes of learning and teaching. Dr. Kaya and his colleagues have their challenge of taking the reader of this book to a journey in the glamorous world of the most basic human experiences.

It is our own challenge to achieve the task of preparing this edition of the book without changing its authenticity. In this sense we expect the authors’ and reader’s courtesy for probable errors. I am indebted to our translators who created this edition with their responsibility and hardworking.

Assist. Prof. Dr. Ahmet Selçuk Akdemir
Co-Editor

LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

CONTENTS

CHAPTER 1: DEVELOPMENT AND LEARNING.....	1
Prof. Dr. Zeki Kaya	
CHAPTER 2: BEHAVIORIST APPROACH.....	19
Prof. Dr. Hasan Bacanlı	
CHAPTER 3: COGNITIVE LEARNING THEORIES.....	31
Assoc. Prof. Dr. Nadir Çeliköz, Assoc. Prof. Dr. Yavuz Erişen, Assoc. Prof. Dr. Mehmet Şahin	
CHAPTER 4: SOCIAL LEARNING THEORY (SOCIAL COGNITIVE THEORY).....	47
Assist. Prof. Dr. Ramadan Eyyam, Assist. Prof. Dr. Nazan Doğruer, Ph.Dc. İpek Meneviş	
CHAPTER 5: CORRELATIVE LEARNING.....	60
Assoc. Prof. Dr. Mehmet Arif Özerbaş	
CHAPTER 6: THEORY OF MULTIPLE INTELLIGENCES.....	72
Assist. Prof. Dr. Öykü Özü	
CHAPTER 7: PROJECT BASED LEARNING.....	83
Assoc. Prof. Dr. Melek Çakmak	
CHAPTER 8: MASTERY LEARNING MODEL.....	100
Assoc. Prof. Dr. Durmus Kılıç, Assoc. Prof. Dr. Kerim Gündoğdu, Assist. Prof. Dr. Yücel Kayabaşı	
CHAPTER 9: CONSTRUCTIVIST APPROACH.....	116
Assist. Prof. Dr. Engin Baysan, Prof. Dr. Fatoş Silman	
CHAPTER 10: BRAIN-BASED LEARNING.....	133
Assoc. Prof. Dr. Bahadır Erişti, Assist. Prof. Dr. Celal Akdeniz	
CHAPTER 11: PROBLEM-BASED LEARNING.....	154
Assoc. Prof. Dr. Hidayet Tok	
CHAPTER 12: REFLECTIVE THINKING AND TEACHING REFLECTIVE THINKING.....	167
Prof. Dr. Ali Murat Sünbül, Assist. Prof. Dr. Ahmet Kurnaz	
CHAPTER 13: CRITICAL THINKING AND HOW TO TEACH CRITICAL THINKING SKILLS.....	174
Prof. Dr. Ali Murat Sünbül, Assist. Prof. Dr. Ahmet Kurnaz	
CHAPTER 14: COMPUTER ASSISTED EDUCATION.....	194
Assist. Prof. Dr. Erinc Karataş, Assoc. Prof. Dr. Serçin Karataş, Prof. Dr. Halil İbrahim Yalın	
CHAPTER 15: DISTANCE EDUCATION.....	213
Assist. Prof. Dr. Erinc Karataş, Assoc. Prof. Dr. Serçin Karataş, Prof. Dr. Zeki Kaya	

CHAPTER 3: COGNITIVE LEARNING THEORIES

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(Translated by Sakine Koca Sincer)

Cognitive Approach in the Process of Learning

Studies related to how a person learns and how learning can be efficient have a long history. Various theories and approaches have been developed in this field and they have had important impact on endeavors for learning. Pedagogues make a classification based on three basic approaches while dealing with learning theories. These are behaviorist approach, cognitive approach and constructivism. It will be a mistake to see these three approaches as alternative to each one or to evaluate them independently while making a classification. Behaviorist, cognitive and constructivist ideas and principles overlap in many fields¹. It is difficult to classify these theories in this context. Some theories can be involved in more than one class in different ways. For example; in some resources, Bruner's theory of Discovery Learning is accepted to be cognitive rather than developmental. In some other resources, Bruner is mostly included in developmental or constructivist class. On the other hand, while Albert Bandura is mostly classified as behaviorist, Bandura himself opposes to behaviorism. This difficulty in classification is natural. Because it is impossible to make a statement independent of behaviorist approach while dealing with cognitive approach or to make a statement independent of cognitive approach while handling constructivist approach. In other words, behaviorist approach provided a basis passing to cognitive approach while cognitive approach provided a basis passing to constructivist approach. According to this, cognitive approach does not deny behaviorism, it claims that cognitive process is seen in behaviorist learning. Moreover, constructivist approach established its principles on the basis of the principles of cognitive approach. According to behaviorist approach, learning depends on stimulus and response to a stimulus, and the resulting behaviour should be observable and measurable. While passing from behaviorist approach to cognitive approach, the question if cognitive process is present or not in acquiring behaviour started to be asked. We cannot say that cognitive psychologists completely exclude the findings of behaviorists. Cognitive processes and activities such as processing information, mental representations, guesses and expectations are accepted to be a basis in the interpretation of learning. What cognitive theorists do in addition to behaviorists' findings is that they claim cognitive processes are also present in the events of an organism's learning.

In this chapter, cognitive approach is explained while the theories below are also included considering learning theories, which are explained, in separate chapters in the book.

Latent Learning – Place Learning

The theory of latent learning was developed by Edward Chance Tolman (1886-1959). Tolman, who made great contributions to the fields of learning and motivation, presented his theory of cognitive learning while working in California University, Berkeley. Tolman, who is accepted to be a cognitive behaviorist today, developed his own sense of behaviorism in a period when ideas related to learning psychology claimed by J.B. Watson (1878-1958) were dominant. According to Watson, behaviours are accepted to be a movement by various muscles. Human behaviours such as speaking, walking, thinking, feeling and such are all composed of movements of nerve system and muscles. According to Watson, concepts such as instinct, motive, conscious, subconscious presented by other theories in order to explain human behaviours are uncertain expressions trying to explain muscular movements and neural activities. He said that learning occurred related to how an organism establishes a connection between his/her information and cognition about the environment and himself/herself.

LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

This idea does not comply with the ideas of Thorndike and Hull, who thought that learning as a strict connection of stimulus-response.²

Tolman claimed that learning was related to complex mental processes, not simple mechanic conditioning processes. He did a lot of classical experiments with mice in order to prove his idea. One of his most well known studies involves maze running. Moreover, he also put emphasis on the role of reinforcer in mice's learning their ways in complex mazes. These experiments caused the birth of "The Theory of Latent Learning" expresses as the learning occurring in situations where there is no certain reward³. Hugh Blodgett did the first experiment making use of the paradigm of learning without reinforcer in 1929 and he was the first academician who used the term of latent learning. He announced this concept, which he put forth as a result of the experiments he carried out with mice in 1929, in "university of California publications in psychology" through an article, which he published with the name of "the effect of the introduction of reward upon the maze performance of rats" in the same year. Then, Tolman also did equaling experiments and developed studies in this field and mentioned Blodgett as the creator of the term "latent learning." Tolman also stated in his article named "cognitive maps in rats and men" published in "The Psychological Review" that it was again Blodgett who did the first experiment in this field. Tolman called the first learning occurring when trials without a reinforcer were done as "latent learning." People apply this kind of learning every day while driving car, walking through the same path daily, and they learn the places of various buildings and places. However, learning appears when we need to find out an object or building.⁴

Cognitive Maps

Tolman's term of "cognitive maps" which he used to explain the learning behaviour of an animal in a maze states that the animal develops a schema of spatial relations, a cognitive map related to the places of objects rather than a simple chain of stimulus-response. That a monkey, which is not hungry, can easily find out the places of the food when it gets hungry after discovery behaviours in test environment, even long after that and other similar experimental observations support the presence of such a cognitive map.

Living organisms constitute a map in their mind about their physical environment. Information such as where and how to go is acquired through these maps. These maps are called cognitive maps and they are constituted unwittingly to a great extent.⁵

Purposive Behaviorism

Tolman called his own specific behaviorism as "purposive behaviorism."⁶ According to Tolman, one of the most important features of human and animal behaviours is that behaviour is goal-oriented.⁷ Tolman used the terms of purposive or molar behaviour in his book, *Purposive Behaviour in Animals and Men* (1932). He claimed that studies should focus on molar behaviours, not on small units of behaviours or actions as claimed by behaviorists. According to Tolman, behaviour is purposive; behaviour has a quality to be able to be changed and adapted in line with environmental conditions for the purpose. When behaviour is purposive, the purpose can be to avoid something or to gain some other thing. For example; while a bird in a cage tries to flee away from the cage, a seller tries to gain profit through a sale of his/her goods. Tolman called his theory purposive behaviorism since he organized behaviour around a purpose.

Tolman's learning theory is one that unites behaviorism and Gestalt. Tolman tried to explain how a human or animal behaviour is related to their purposes, intentions, information, thinking, plans, making sense.⁸

Molar Behaviorism

Tolman defended molar behaviorism contrary to Watson's molecular behaviorism. Tolman stated that behaviorists overlooked the whole while they were analyzing behaviour as very small units. He used the term of molar to mean a kind of global behaviour that could be observable in daily life every day. For example; cooking, washing up, and writing the answers in an exam are some examples. According

LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

to Tolman, studying behaviour by means of dividing it into small parts and elements cause the loss of behaviour's meaning. Therefore, purposive behaviours that have unity in meaning should be studied⁹.

Extinction

According to Tolman's theory, extinction comes out because of changes in the expectations to a great extent. If an organism is certainly aware of the fact that a sign will not guide a reinforcer anymore, extinction occurs and the reason of this extinction is that the organism does not need it anymore.¹⁰

Variables of Learning

Tolman addresses the variables of learning in two groups such as environmental and individual differences.

Environmental variables: The behaviours to be displayed differ according to environmental qualities. Different ways are tried in order to achieve a certain goal. What is important is to achieve a goal in the shortest and easiest way. A person who prefers to use public transportation to go to work when it is snowy while he/she goes to work by his own car when it is not snowy is an example. Some of the environmental variables are¹¹:

- Nutrition program: This concept refers to schedule of depriving an animal. For example; the duration of time since an animal's eating.
- Coherence of purpose object: It is the coherence of reinforcer stimulus with the instinctive situation of the animal. For example; food cannot be a reinforcer for a thirsty animal.
- Type and Suitability of Stimuli: It is the suitability of signs and clues given to the animal.
- Type of Motor Responses Necessary in the Case of Learning: Running and sharp turns are examples.
- Type of Running in a Maze and Being Successful: The form of way turn necessary for analyzing a maze determined by the experimenter.
- Number of Trials and Accumulative Nature of These Trials

Individual Variables: There are some qualities that differentiate individuals from each other. According to Tolman, these are heredity, age, and previous education, organism's condition about hormone, drug and vitamin. These qualities are shaped according to the qualities of environment. For example, teaching reading and writing is more common in the first grade primary education. While some of first grade students learn how to read and write earlier, some others learn later than them. The most important factor here is individual differences¹².

Intervening Variables: The term of intervening variable describe psychological processes that intermediate between the environmental stimulus directing the behaviour and observable responses.¹³ Organism achieves a given goal by means of using many various alternative paths, not a single way. Tolman tried to explain the causes of the variety of complex and molar behaviours. Tolman answered this question making use of the term of intervening variable. Intervening variable is a structure built to help to explain the relation between independent variable and dependent variable. Tolman accepts cognition to be intervening variable. Cognition is an element that intervenes both stimulus and response.

Discovery Learning

In today's world, the demands of business world from education have changed in parallel to the global economical competition. Business world primarily wants its workers to have problem solving skills. Business world calls its workers to find new ways by means of thinking over what they can do and how they can do what they do more easily and more competitively¹⁴. As economic competition increases at global level, business world starts to need individuals who can be more successful through a small training after being recruited¹⁵. Our society now needs graduates who can cooperate, work in teams, teach others and negotiate with others¹⁶. Both business world and society expect graduates who can collect data in order to reason and solve a problem, and who can interpret and evaluate the data¹⁷. Individuals graduating from schools that give education through traditional methods do not possess these skills. In this context, discovery learning is accepted to be a new

LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

approach to raise up future graduates having all the skills mentioned above. In this approach, special learning methods and learning strategies based on guidance play an important role.

Discovery learning is accepted to be natural part of human beings.¹⁸ People are born with an innate curiosity and this curiosity causes them to learn.¹⁹ Babies learn how to talk through discovery learning. They listen to what is spoken around them, imitate sounds and try to unite speaking parts they have explored.²⁰ Although discovery learning is generally said to be represented by Bruner in the books and articles, there are some ideas developed by John Dewey, Jean Piaget and Lev Vygotsky at the base of this theory.

Dewey, in his book called *Democracy and Education*, describes learning as an action which requires learners to be in a society, to put the ideas and information together when they communicate with others, and also which requires these individuals to constitute their information by means of implementing the results of their meaningful and important past experiences. According to Dewey, children naturally possess active learning motivation and education just helps to make it possible to learn more.²¹ According to Dewey, mental development starts with social interaction. Namely, children are not receivers but participators of learning.

On the other hand, Jean Piaget, in his book *Understand is to Invent*, states that understanding results from discovery, that productivity and creativity will be lost, and an individual will be got stuck in repetition without understanding. According to Piaget, children cannot think in the same way with adults²². It is Piaget who first claimed that children were not empty containers that need to be filled with information, that they were individuals who could actively constitute information. According to Piaget, children are individuals who continually create and test their senses of the world. In other words, they are active and participating students.

Lev Vygotsky puts special emphasis on the importance of cultural and social effects, and children's interaction with others in cognitive development.²³ In the term of "Zone of Proximal Development" put forward by Vygotsky, there is a difference between what a child can succeed alone and what a child can succeed with help. In other words, if his/her peers, teachers or parents who can help to constitute the necessary experiences, accompany the child this child can solve more complex problems in a certain mental period. According to Vygotsky, determining a student's place while developing and structuring childhood experiences for richer inventions will strengthen education in class.

The Features of Discovery Learning

Traditional learning comprises teaching activities and explanations in class under the leadership of the teacher. On the other hand, basic foundations of discovery learning are learning occurring in the individual, teaching and learning strategies designed by the teacher, and the atmosphere created by using these strategies. Indeed, discovery learning is not a new theory. Principally, teaching models and strategies focusing on active and applicable learning opportunities for students aim at learning through discovery learning²⁴⁻²⁵⁻²⁶. Bicknell-Holmes and Hoffman lay stress on three features of discovery learning²⁷:

1. **Exploring and problem solving in order to create, integrate and generalize information:** The most important feature of discovery learning is this first one. Students can take on active roles in order to create, integrate and generalize information through exploring and problem solving. Students can constitute more comprehensive implementations for their skills through activities that encourage taking risks, problem solving and testing their unique experiences instead of receiving information passively through presentation, explanation or exercise. Because of this feature of discovery learning, students carry out the deed of learning instead of teachers. Thus, the roles of teachers and students change completely, and most of the teachers have difficulty in accepting this radical change in the roles²⁸.
2. **Activities whose sequence and frequency are determined and carried out by students, and which depend on students' interests:** The second feature of discovery learning is that it encourages students to learn at their own speed.²⁹ There may be a flexibility about the sequence and frequency of learning activities through discovery learning. Learning is not the static progress

LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

of lessons and activities. This feature of discovery learning contributes much to students' motivation and their taking responsibility of their own learning.

3. **Encouraging to integrate new information to the current information of students:** The third feature of discovery learning is the use of the current information as a basis in order to structure the new information.³⁰ Scenarios familiar to students help students to extend their current information and find new information on this current information. Papert's discussion on the case when nursery school students come across LOGO computer program is one of the most important examples of this case³¹. Papert changed the speed regulation of the program and thus maintained the real meaning of zero to be found. Student explored that steady objects moved at zero speed. Papert achieved to create a new understanding of concepts about zero and other numbers by means of changing something familiar to student.

Comparison of traditional approaches and principles of discovery learning:

Learning is not passive, it is active: Students are active in discovery learning. Learning is not just receiving what is read or said, but it is following the new information actively. Students are involved in applied activities composed of real problems waiting for a solution. The real goal is to find the answers and learn more³².

Learning is process-oriented rather than content-oriented: In discovery learning, focus has shifted from final product, namely, from content to process, namely, to how content is learnt. Analysis and interpretation are present in order to understand what is learnt instead of giving the correct answer directly. Discovery learning helps students to go into a deeper level of understanding. It focuses on having important skills and implementing these skills³³.

Failure is important: In discovery learning, failure is accepted to be a positive situation.³⁴ Thomas Edison, who tried 1200 designs until he found out the working bulb, is a good example of this feature³⁵. When Edison was asked if so much failure discouraged him or not, he replied that he was never discouraged because he learnt thousands of useless designs. So, learning can occur even through failure. Discovery learning does not focus on finding the correct answer. Cognitive psychologists have shown that failure is in the center of learning.³⁶ What is essential is learning and a lot can be learnt through failure, as well. If a student never fails while learning, this probably means that she/he does not learn a new thing³⁷.

Feedback is necessary: An important portion of discovery learning is that there are opportunities of feedback in learning process.³⁸ Student's learning is strengthened, deepened and maintained to be more permanent by means of discussing a topic with other learners. Discovery learning provides opportunities of deeper understanding by means of putting all these differences together. Students make a natural progress and internalize concepts.⁴⁰

Dr. Roger Schank and Chip Cleary constituted five categories about implementing discovery-learning theory in class⁴¹:

1. Case-based learning
2. Incidental learning
3. Learning by exploring/conversing
4. Learning by reflection
5. Simulation-based learning

Meaningful Verbal Learning

David Ausubel (1918-2008), founder of Meaningful Verbal Learning, was an American psychologist who completed his PhD education in Developmental Psychology in Columbia University. He was influenced by studies carried out by Piaget, and he published many books on developmental and educational psychology. He is accepted to be a neuro-behaviorist because of his studies in the field of educational psychology. Although Ausubel recognized other forms of learning, his studies focused on verbal learning.

LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

Ausubel, who dealt with the structure of meaning, believed that external world could make sense only when it could be transformed into learner's conscious content. Meaning is created through equality of representation between language, namely, symbols and mental context. Here are two processes:

1. Perception: present in meaningful verbal learning
2. Discovery: present in concept formation and problem solving.

Ausubel's studies can mostly be compared to Bruner's studies. Both psychologists researched the structure of information, but Bruner focused on discovery processes while Ausubel focused on verbal learning methods such as speaking, reading and writing. According to Ausubel, people primarily learn a piece of new information by means of being directly exposed to information rather than discovery⁴². According to Ausubel, student does not need to make a discovery for a meaningful learning to take place; students receive information readily rather than through exploring. Because of this reason, students should be prepared to receive the information organized by the teacher. In meaningful learning, lesson goes on in the direction from whole to piece, in other words, with deduction. It is important to associate and re-organize what is learnt at each phase. If the whole is not presented and preliminary learnings are not reminded, students will tend to memorize. Ausubel believes that concepts, principles and ideas are gained through deductive reasoning⁴³. According to Ausubel, learning should be meaningful. Verbal learning can be meaningful if it is carried out efficiently, but discovery learning may not be meaningful every time. Moreover, verbal learning is more advantageous than discovery learning because a lot of information can be transferred to the student in a short time if verbal learning is carried out efficiently. Ausubel, who believed in the idea of meaningful learning as opposed to rote memorization, says in the preface of his book called *"Educational Psychology: A Cognitive View"*. "If [he] had to reduce all of educational psychology to just one principle, [he] would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly⁴⁴." In other words, the most important factor that affects learning is the current fund of knowledge. This fund should be revealed and teaching should be planned accordingly.

In Ausubel's approach of meaningful learning, organizer information plays an important role. These are starter expressions constituted by high-level concepts. An organizer can be a concept, a principle, a generalization and a rule. It is an advance organizer, a piece of information presented by the teacher, which helps student to organize the new information⁴⁵. Advance organizers help the process of learning when difficult and complex materials are presented. There are two conditions for this:⁴⁶

1. Student should process and understand the information given as advance organizer. This increases the effect of organizer.
2. Relations between basic concepts and term should be shown making use of organizer.

Types of Organizers

Ausubel's theory of advance organizer is dealt with in two categories. These are comparative and expository organizers. The main goal of comparative organizers is to activate existing schemas. Similarly, they act as reminders to bring into the working memory of what you may not realize is relevant⁴⁷. By acting as reminders, the organizer points out explicitly "whether already established anchoring ideas are nonspecifically or specifically relevant to the learning material"⁴⁸. Similarly, a comparative organizer is used both to integrate as well as discriminate. It integrates new ideas with basically similar concepts in cognitive structure, as well as increases discriminability between new and existing ideas, which are essentially different, but confusably similar.⁴⁹ An example of a comparative organizer would be one used for a history lesson on revolutions. This organizer might be a statement that contrasts military uprisings with the physical and social changes involved in the Industrial Revolution⁵⁰. On the other hand, expository organizers are often used when the new learning material is unfamiliar to the learner. Here it is aimed to make the unfamiliar material more plausible to the learner. An example, which Ausubel and Robinson provide in their book *School Learning: An Introduction To Educational Psychology*, is the concept of the Darwinian theory of evolution⁵¹. To make the Darwinian theory of evolution more plausible, an expository organizer is used as combination of relatedness to general relevant knowledge that is already present, as well as relevance for the more detailed Darwinian theory. Another example would be the concept of a right angle in a

LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

mathematics class. A teacher could ask students to point out examples of right angles that they can find in the classroom. By asking students to do this, it helps relate the students' present knowledge of familiar classroom objects with the unfamiliar concept of a 90-degree right angle⁵².

The steps stated below are used while implementing meaningful verbal learning in class:

1. Presenting advance organizers: Organizers such as explanation, schema, model that draw the outline of the lesson and make a structure for the new information are presented. These organizers constitute the skeleton for new information, attract attention to important points and relate current information to the to-be-presented learning material.
2. Presenting the new information: New information is introduced from the general to the specific making use of deduction. Discussions and conversations contribute to student's learning process. Teaching goes from general information to concrete examples. Previous and new pieces of information are compared and the differences and similarities between them are discussed.
3. Reinforcing cognitive organization: In this step, given information is tried to be fully integrated into the structure presented at the beginning. It is important to determine whether the student makes sense of what is learnt or not. Activities such as exercises and problem cases are used to have students transfer information to new situations.

Gestalt Theory

Wolfgang Köhler (1887-1967) is one of German Gestalt psychologists. He is one of the founders of psychology school called Gestalt during the period when behaviorism was dominant in psychology in the USA⁵³. He studied physics and psychology by the guidance of Max Planck and Karl Stumpf. It is possible to see how Köhler, whose PhD thesis was on psychoacoustics, transferred the field of physics to psychology.

Gestalt psychology, founded by Wertheimer, Koffka and Köhler, is a reaction to behaviorism, which reduced experiences to simple stimulus-response reflections, and a reaction to constructivist perception theories, and reduced experiences to pieces, which were defended by Wundt and Titchener⁵⁴. Gestalt psychology, which has its root at Husserl's phenomenology and Kant's philosophy, accepted perceptual process as a synergic cooperation, which united perceptual elements and constituted a holistic interpretation of a stimulus, and where parts are much less important than the whole⁵⁵. This theory states that an individual evaluates stimuli coming from outer world as a gestalt rather than receiving them by means of isolating: "The whole is greater than the sum of the parts." When one looks at a portrait, she/he sees a portrait, not parts such as nose, eyes, lips, hair separately. The music composed of the contributions by all the musicians is listened rather than the single contribution of each musician at a concert.

Köhler's experiments with animals are accepted to be one of his most important contributions to the field of psychology⁵⁶. His studies, which he carried with the name of "The Mentality of Apes", were published in 1917. In this study, Köhler almost spent all his time on a group composed of nine monkeys kept in a cage for the purpose of research. A monkey called Sultan made a great progress in terms of intelligence and turned out to be Köhler's favourite experimental object⁵⁷. Köhler used food as a means of motivation and firstly tested chimpanzees' ability to solve problem⁵⁸. He observed Sultan, his smartest ape, to unite branches of bamboo and use it as a means to reach the food located in a long distance away from the cage⁵⁹. In another case, he observed that one of the apes solved the problem of reaching the bananas hanging on the ceiling by means of putting boxes as a pile and climbing on this pile to get the bananas⁶⁰. Based on his observations, Köhler concluded that apes did not carry out these missions through trial and error or luck, but they used "introspection"⁶¹ and he explained the behaviour of apes' problem solving in terms of cognitive processes. According to Köhler, these animals can learn how to solve problem just like humans. These behaviours of apes are carried out through a mental process. One of the most important contributions of Gestalt theory to education is the application of introspective problem solving and productive thinking. Student should be exposed to all elements of a problem in order to acquire introspective problem solving behaviour. Namely, the problem and the elements necessary for the solution should be presented to the student. The appropriate atmosphere should be prepared for the student to understand the nature of the

LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

problem, explore the relations between its elements and organize the possible ways of solution, in other words, to make an invention. For this purpose, curiosity of the student is moved⁶².

According to Gestalt theorists, an individual perceives the whole as a meaningful and organized whole, not through separating the whole into parts. Then, he/she discovers the relations between parts and the whole. Moreover, relations of simplicity, similarity, proximity, and continuity, shape-base are important in perception. In this case, the teacher should give the basic framework of the lesson as an organized and meaningful whole to the students at the beginning of the term, and then should go into details. Thus, the teacher can help students to understand the function of the lesson and relations between the units as a whole⁶³.

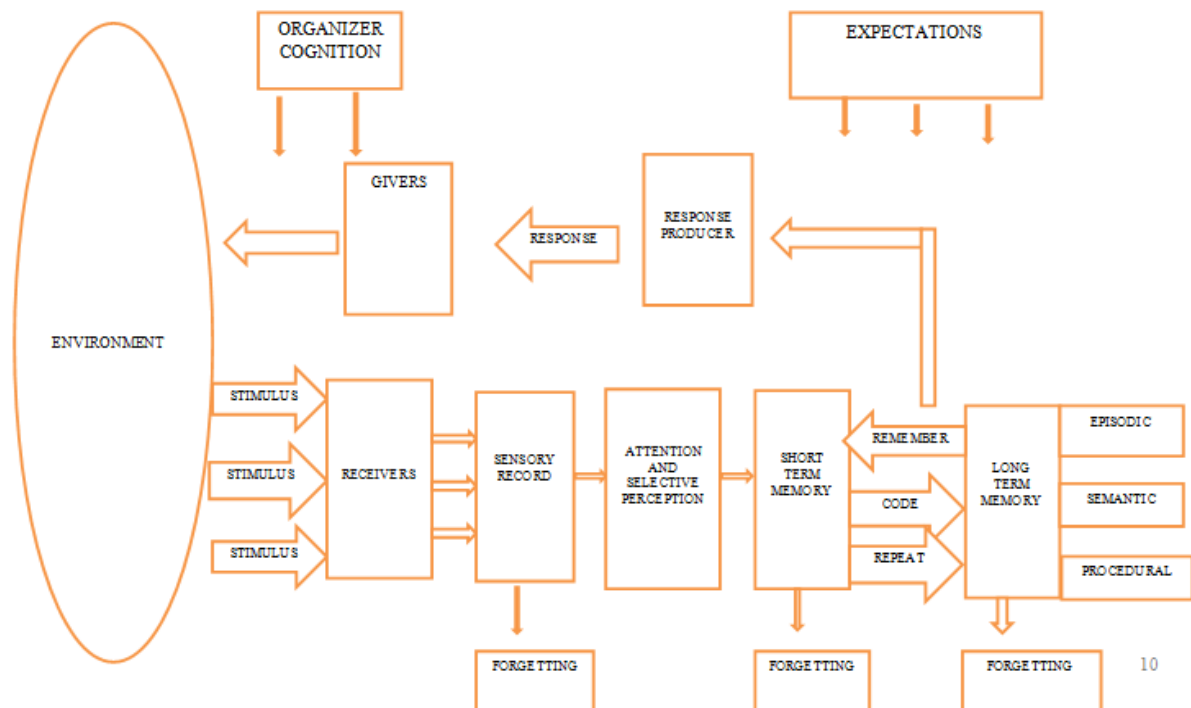
Theory of Data Processing

Theory of data processing is a theory that has been put forth by George A. Miller (1920-) grounding on Edward C. Tolman's (1886-1959) sign and latent learning theories, that claims that learning is a complex and internal process occurring with some mental processes, and that is based on cognitive approach. Theory of data processing accepts information as the basic means of learning and explains learning in terms of memory system. It focuses on how information goes into the memory, how it is stored there and how it is retrieved in case of need. In the theory of data processing, the process starts with receiving the stimulus coming from outside through sense organs, and goes on with describing and storing of these stimuli. This stored information can be retrieved and used when necessary. This system is compared to computer systems and it is shown with a model expressed as the model of data processing (Schema 1).

Model of data processing is composed of three main elements such as (1) information stores, (2) cognitive processes and (3) executive cognition. **Information stores** is the first element of data processing model and refers to the places where information is stored. It is composed of three different types of memory such as (1) sensory record, (2) short-term memory (processor) and (3) long term memory. These are the steps of data processing at the same time. The stimuli received from around firstly go into sensory memory through sensory organs. Then, the raw information here is transferred to processor memory with the help of attention and perception. In the processor memory, raw information is made sense by means of thinking over them and uniting them with the information in the long-term memory. Here, information is turned into behaviour or transferred to long-term memory in order to keep by means of meaningful coding. Long-term memory is the data store where information is continually stored. It has got three different parts where different types of information are kept such as (1) semantic memory, (2) recollectional memory and (3) operational memory. *Semantic memory* mostly stores verbal information (concepts, principles, generalizations) while *recollectional memory* records events, phenomenon, time and places that have a shocking or deep effect. *Operational memory* is part of the memory, which stores types of skills, ordinal, applied, and methodological information. The second element of data processing model is **Cognitive Processes**. Cognitive processes are mental activities that help information to transfer from one memory to another. These are composed of processes such as *attention, perception, repetition, coding and retrieving*. In the cognitive process, the information, which is wished to be learnt, is chosen by means of *attention* as stimulus or raw information among other information, and it is turned into meaningful information through *perception*. Those pieces of information that are wished to be kept forever are transferred from processor memory to long term memory by means of *repetition*. Through *coding* which means formation of mental symbols of information, information is transferred to long-term memory and stored there. When information is wished to be used again, process of *retrieving (remembering)* comes foreground, and the wanted information is looked for and found among the information stored in the long term memory and then it is transferred to processor memory for use. Learning individual does this sometimes intentionally and sometimes automatically. *Forgetting* as opposed to retrieving or remembering means eliminating information from the memory or not being able to retrieve it. The third element of data processing model is composed of executive processes called **cognition information or executive cognition**. *Executive cognition* maintains that information stores and cognitive processes to operate in harmony in data processing. Executive cognition has an individual quality, and the learning individual controls and directs cognitive processes

LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

called as attention, perception, and repetition coding and retrieving with his/her own cognition information.



Graph 1: Information Processing Model

Information Stores Sensory Record

The first step of gaining information and the first unit of memory system is sensory record. An individual is always under the effect of stimuli coming from around. An individual is exposed to a lot of information at one time by means of seeing, hearing, touching, tasting and smelling. For example, a student in class is under the effect of thousands of stimuli such as the sunlight coming through the window, the teacher's voice, reflection of data show, colour of the wall, the hardness of the desk she/he is sitting on, whispers of friends, hunger, etc. However, among the endless stimuli coming into sensory record, a few ones, which attract attention, which comply with the expectations and aims of the student, are chosen and sent to short term memory; others are lost. Although the capacity of sensory record is limitless, the stimuli coming here can stay here only for a few seconds (0.5-3 sec.). For example, when a picture is passed in front of the eyes quickly, its sign stays in the eyes for a second, or when a fly touches on cheek, it is felt at the very moment. These examples show that stimuli go into *sensory record* and the process takes place for half of a second. The presence of sensory record is of critical importance for human life. If a person forgot the first words of a sentence she/he was reading or hearing before it is completed, it would not be possible to make sense of this sentence. The information included in sensory record is exactly the same as the stimulus going into the record. Visual senses are coded as photograph and audio senses are coded as voice just for a few seconds. Stimuli need to be transferred to short term memory by means of the processes of attention and perception in order to be conscious and meaningful pieces.

Short Term Memory

The information chosen through the processes of attention and perception among the sensory record goes into the short memory, which is the second element of the system. Short-term memory, which is also called as processor memory or active memory, is the memory where limited amount of

LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

information is stored temporarily for a limited time. Both the duration of time and capacity to keep information are limited. Short-term memory can keep about $7(+/-2)$ units of information (letter, number, shape, sentence, photograph, etc.) for about 20-30 seconds. Short-term memory is in contact both with sensory record and long-term memory. The information coming to short-term memory is either filtered, organized and turned into behaviour to be used or is stored in the long-term memory by means of relating to the current information and coding. Information should be repeated to stay in the processor memory for a while. Moreover, it is important to use some strategies such as repetition, memorization, making sense, associating and grouping to increase the capacity of short-term memory.

Long Term Memory

Long-term memory is the place where new information coming from short-term memory is united with the previous information and stored. Abbot defines long term memory as a more permanent store where information can stay asleep, out of conscious and without being used until it is called back to the conscious⁶⁴. The information processed in short-term memory is sent here to be kept for a long time. So, this can be compared to a library. The limits of long-term memory are not certain. The duration of time when information is kept here is very long. Information, which is active, in short term memory stay passively in long term memory and a certain time should pass for this information to be remembered. Information is retrieved from long-term memory sometimes intentionally and sometimes automatically when necessary. However, the problem here is to use the correct information when necessary. If information is not coded and located appropriately, there may arise difficulties in retrieving.

Tulving (1993) divides long term memory into three: these are (1) Semantic memory (2) Episodic memory and (3) Procedural memory. Tulving⁶⁵ is the one who first pointed the difference between episodic memory and semantic memory while all the discussions about the topic consider these two different types. Today, many researchers unite them in a more comprehensive category and call it as declarative memory. Some other researchers have defined extra memory types. For example, Abbot uses declarative and procedural memories. Huitt adds imaginary memory to this list⁶⁶. However, Pylyshyn states that imaginary memory does not have a different structure of organization, but it is subject to the rules applied to semantic and episodic memories⁶⁷.

Semantic Memory: It is the place where information gained through experience is stored. Concepts, phenomena, rules and generalizations of subject areas are stored here. In semantic memory, pieces of information are connected to each other as verbal and visual networks. A pattern is formed for each concept and process, and a relation is established with current patterns. The ways included in the mind map are followed in order to reach the information in semantic memory and any of the many ways can be chosen to reach the same information. According to Anderson (1985), the more connections there are among the concepts in a concept network, the easier it is to reach the related information since if one cannot reach the information through a way, another way can be used. Thus, it gets more understandable that not information but the ways to reach this information are stored in long-term memory. The better a mind map is organized and the more meaningfully it is built, the stronger memory gets.

Episodic Memory: Episodic memory is composed of memories that give the sense of remembering real situations and events⁶⁸. It is the place where personal experiences are stored. Information in the episodic memory is stored as images organized according to when they were formed and where they occurred. According to Paivio, image is defined as structure of memory that collects and store information about pictures. It catches information just like a photograph and it can also be very useful in terms of visual presentation and context of the information⁶⁹. Important events such as festivals, military service days, the day when one hears the news that she/he passes university entrance exam, the first day at work, marriage, etc. are remembered easily while it is difficult to remember ordinary events that are repeated continually since new events can spoil the previous ones.

LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

Procedural Memory: It is the memory where information and processes about how a job can be done are stored. Formation of procedural memory takes a long time, but once it is formed, its quality of being permanent and remembered is very likely to be seen. For example, learning how to drive a car takes a long time, it requires many steps of processes, but it is almost impossible to forget it. The more a process is repeated, the more likely it is to turn into a natural reaction.

Cognitive Processes

Attention: It is the power to focus on a certain stimulus and it constitutes the focal point of conscious. In other words, it is a kind of heading in order to response to stimuli. Suthers defines attention as the limitations about perceptual process and producing answers⁷⁰. Data processing starts with attention. Stimuli coming from outside come into sensory record first of all and here the stimulus is sent to short term memory and kept without making any changes, as it is taken from outside. Stimuli towards which attention does not head are lost. Namely, attention determines which information will pass to short time memory and which will not. Individuals have the capacity of directing their cognitive strengths towards certain resources of information in the environment. In other words, selective attention is under the control of the individual and efficient learning depends on the selective ability of the individual.

Perception: It can be defined as the process of describing the stimuli received through sensory organs or the process of turning sensory signals into meaningful experiences. In the process of perception, what stimulus is decided? As each individual has his/her own way of organizing the received signals, their perception of the signals also differs. An individual can pass just the information she/he can perceive among the environmental stimuli coming into sensory memory.

Repetition: Information is stored through repetition in order to stay in short term memory longer. The reason why duration of keeping is longer is that coding is carried out and information is not lost before being sent to long-term memory. Stimulus or stimuli should head towards reaction. "Perception has an active and selective quality, and an individual's perception of a certain stimulus or stimuli's situations is based on efficient preparation and directions"⁷¹.

Coding: Most of the information coming from around is stored temporarily without coding. Coding is the transfer of information by means of relating the information in long-term memory to the information in short-term memory. The individual to be sent to long-term memory should code information meaningfully. Each individual carries out coding in the most meaningful way according to him or her. There are four basic elements in enriching the process of coding by means of increasing the meaningfulness of information⁷²: Efficiency, organization, articulation, and memory supporting clues.

Storing: Anderson and Bower suggested an important model in order to explain how accumulated information is stored. This model is based on the idea that information is established on verbal units including structures of subject and verb rather than perceptions⁷³. Information is stored in long-term memory. However, during the process of storing, information is stored in the appropriate part among episodic, semantic and procedural memories. Thus, the process of retrieving is carried out correctly.

Retrieving: It is looking for, finding and activating the information stored in the long-term memory. What is important is to find out the clues that will retrieve the stored information in this process. According to Ashcraft, there is no real forgetting in long term memory. Forgetting is failure in retrieving⁷⁴.

Executive Cognition

Executive cognition is the information about cognition. Executive cognition is about learners' skills to use learning strategies and handling the thinking types⁷⁵. In other words, it means that an individual is aware of the fact that his/her own cognition structure and learning qualities are different. A student with executive cognition is aware of his/her own way of thinking, she/he does not focus on just learning the material while deciding how to study, she/he is also aware of his/her cognitive

LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

weaknesses and strengths. The process of executive control explains the answers of the questions why some individuals learn and remember what they have learnt more than others. Executive control is the name of the system that controls all the cognition processes of an individual. This system controls two basic aspects of learning. The first one is about motivational processes. Motivational processes are composed of situations that can be controlled by the individual consciously such as intending to go for aiming at getting something. The second one is composed of all the processes about data processing⁷⁶. It is claimed that executive cognition has two functions⁷⁷. One is implementing conditional information. For example, what is learnt at school is implemented at home. The next one is about evaluating and executing the process of thinking. Individuals differ in terms of executive cognition and this difference is about developmental process (biological differences and differences of experiences). Executive cognitive abilities start to develop at 5-7 years and continue to develop in school years. In this process, teaching is more efficient than maturation⁷⁸. These are the important points in terms of data processing⁷⁹:

1. Changes of brain occur by means of biological maturation or experience;
2. Increasing process capacity, speed and efficiency are each a result of maturation and information development;
3. Changes of connection occur in nerve networks;
4. Concepts that come out without organizing itself and repeated are a result of the adaption to changing environment;
5. Problem solving and metacognitive capacities increase.

SUMMARY

- Pedagogues mostly classify three basic approaches while dealing with learning theories. These are Behaviorist Approach, Cognitive Approach and Constructivism.
- It is impossible to make an explanation independently from behaviorist approach while dealing with cognitive approach or independently from cognitive approach while dealing with constructivist approach.
- Latent learning theory was developed by Edward Chance Tolman (1886-1959).
- Tolman claimed that learning occurred through complex mental processes, not through simple mechanic conditioning processes.
- The term of "cognitive maps" used by Tolman in order to explain the learning behaviours of an animal in a maze expresses that the animal establishes a schema of spatial relations, a cognitive map related to objects' places rather than chain of a simple stimulus-response.
- One of the most important features of human and animal behaviours that attract attention is that behaviour is goal-oriented.
- Tolman defended molar behaviorism as opposed to Watson's molecular behaviorism.
- According to Tolman's theory, extinction takes place mostly because of the changes in the expectations.
- Tolman addresses the variables of learning in two groups, which are environmental, and individual difference variables.
- Discovery learning is accepted to be a natural part of human beings. People are born with an innate curiosity and this curiosity pushes them to learn.
- The founder of The Theory of Meaningful Verbal Learning is David Ausubel (1918-2008).
- Ausubel, who dealt with the structure of meaning, believes that external world can make sense only if it is turned into learner's conscious content.
- According to Ausubel, the student does not need to discover for a meaningful learning, students receive the information as a ready from rather than discovering it. Because of this reason, students should be prepared to receive the information organized by the teacher.
- In meaningful learning, lesson plan goes from the whole to the part, namely, in a deductive way. In each step, it is essential for the student to relate and re-organize what has been learnt.
- In Ausubel's approach of meaningful learning, organizers play an important role.
- Gestalt psychology, founded by Wertheimer, Koffka and Köhler, is a reaction to behaviorism, which reduced experiences to simple stimulus-response reflections, and a reaction to

LEARNING AND TEACHING : THEORIES, APPROACHES AND MODELS

constructivist perception theories, and reduced experiences to pieces, which were defended by Wundt and Titchener.

- Gestalt theory states that an individual evaluates stimuli coming from outer world as a gestalt rather than receiving them by means of isolating: "The whole is greater than the sum of the parts."
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- Theory of data processing accepts information as the basic means of learning and explains learning in terms of memory system.
- It focuses on how information goes into the memory, how it is stored there and how it is retrieved in case of need.
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- Cognitive processes are mental activities that help information to transfer from one memory to another. These are composed of processes such as *attention, perception, repetition, coding and retrieving*.
- *Executive cognition* maintains that information stores and cognitive processes process holistically in data processing. Executive cognition is individual and the learner controls and directs cognitive processes such as attention, perception, repetition, coding and retrieving with his/her current cognition information.

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