CHAPTER 9: CONSTRUCTIVIST APPROACH

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COGNITIVE DEVELOPMENT

The studies of cognitive development deal with how thinking processes of children change in time. Cognition includes the acquisition and usage of the knowledge. Cognition includes not only the processes, which are purposeful and needs diligence bearing decision within but also processes that automatically performed and unconsciously remembrance of any familiar face and object. Cognition cannot be observed directly but it is understood as a result of behaviors. Development defines the changes in construction and function. Cognition studies emerged with the cognitive psychology (and cognitive development) in the 1950-1960s.[1]

BASIC ASSUMPTIONS OF COGNITIVE PSYCHOLOGY

The basic assumptions related to learning of cognitive psychology can be summarized as follows.
- Cognitive processes affects how and what is learned. Cognitive psychologists bring many explanations how the human processes the knowledge in his mind. It is the Information Processing Theory that brings these explanations together. According to this;
- ✓ People learn easier if they associate the new knowledge with their prior ones.
- ✓ If they can combine many independent pieces of knowledge by associating them with each other, people learn these pieces of knowledge easier.
- People have the chance to choose what and how they process and learn. When they are exposed to infinite number of stimulus, people pay attention to only a small part of them or just one of them. They have to make a choice for life or for a more comfortable life. When students are exposed to knowledge constantly, the thing that must done in terms of education is to make them aware of that they don't have to learn everything and to help them in choosing which stimulus they should or shouldn't pay attention to.
- Knowledge is not acquired directly from the environment; instead the learner constructs it. Some cognitive theorists emphasize especially issues related to learner's construction of knowledge and these theories are known as Constructivist Theories. Construction process is at the heart of many cognitive learning theories. A person uses a great number of different knowledge to make sense of his environment, learn and explain what is going on around. At the end of teaching, knowledge is constructed not just as it is presented before, on the contrary it is constructed as suitable for every learner's own mental structure but as different from each other. This makes it essential that during the teaching process it should be determined through questions what the learner have learned and corrections should be made when necessary in order to reach common learning.
- Prior learning and beliefs affect how people construct knowledge in their mind. Main reason for learning different things of students in a class at the end of the teaching process is that each of them has different previous learning and different beliefs. Every student has his or her own experiences and diverse environmental and cultural properties. Many cognitive psychologists believe that knowledge existing in the mind determines what will be learned from new experiences and how effective the learning will be.

- People participate in their own learning processes in an active way. Cognitive psychologists do not believe that people acquire and internalize the knowledge just as it is. Instead, people take part in their learning processes actively.[2]

SOME BASIC TERMS USED IN COGNITIVE PSYCHOLOGY

Four important terms used in cognitive psychology are memory, storing, encoding and retrieving.

1- Memory: It includes the process of storing learned information, the places where information stored –short term (active) memory and long term memory- and skills.
2- Storing: The term –storing- means acquisition of new information and it expresses storing the learned information in memory.
3- Encoding: Knowledge mostly is not acquired as it exists in the environment but it is encoded in memory in a different way –changed and modified (depending on prior learning, beliefs etc.).
4- Retrieving: It is the retrieval and recall of the information stored before. In other words it is the finding of knowledge stored in memory. The recall process is sometimes easy; sometimes more difficult or sometimes pre-recorded information could not be reached.[3]

As a result of studies lasting many years, psychologists have revealed many approaches and theories dealing with why and how a child's thinking processes change. Only the three of them, which are accepted more and thought as more effective –Jean Piaget, Lev Vygotsky and theories of information processing theorists-, are explained here. Each of these theories, in fact, could explain learning and cognitive development partially and it will be the introduction of a full explanation only if they are brought together harmoniously. Criticisms and additions made recently by theorists and educators to these theories and development works based on the three theories are given below.[4]

PIAGET'S THEORY OF COGNITIVE DEVELOPMENT

Jean Piaget (1896-1983), one of the scientists considered as pioneers in learning and cognitive development, had worked with children for many years. Piaget revealed that some ideas and concepts including assumptions related to development of logical thinking. The major of them:

- Children, curious by nature, are active in their learning and motivated. Smedslund, a member of Piaget school, emphasizes that important cognitive process is primarily an "internal organization and coordination" about external motivation[5,6]. According to Piaget, children search knowledge and make sense of the world by questioning it. In this process, children experiment –ask questions like scientists and seek answers of these questions.
- In the process of constructing knowledge, children adhere to their experiences. For instance, Piaget[7] says it is a huge mistake to say that children learn numbers and other mathematical concepts thanks to ordinary teaching and emphasizes that crucial learning occurs with the processes which children enter independently and alone. According to these approaches, children's knowledge is constructed to form a whole but it is not independent and isolated information pile. According to Piaget, children and adults construct their own beliefs and meanings related to the world adhering to their experiences, thus Piaget's views are named as constructivist theory or shortly constructivism.
- Knowledge, in Piaget's words, is constructed in schemas and after new learning, these schemas are organized and developed better and new connections are established. These connections develop after new experiences.
- Learning and cognitive development occurs with processes of assimilation and accommodation, which complete each other[8]. During the process of assimilation, new information is placed in existing schema -without causing any changes in it- during the process of accommodation, either existing schema is changed in the form of including the new information or a new schema is established for the new information. The new information is analyzed to associate by activating (remembering) the existing schemas. Thus, the occurrence of accommodation process is very unlikely without assimilation process.

For the cognitive development, an individual must communicate with his physical and social environment. On the other hand, like children and adults' construction of the information and beliefs related to their physical environment, their own beliefs, other people's beliefs and information about morality can be explained by constructivist approaches. Moreover social interaction is also very important for cognitive development like physical environment. Children interacting with other individuals whose views are similar or not with theirs realize that there may be new views and information and their thought and knowledge are not absolute. With this idea, Piaget pioneered to reveal the existence of information that is not compatible with the idea of "there is no true" which is the other basis constructivist approach and with the debate about proper viewing.

- Balancing process –one's effort to keep the balance of his cognitive structures[9]- allows the development of the structures of thought. Piaget explains the concept of imbalance as the situation of mental discomfort in which new information could not be explained with the existing schemas thus assimilation process cannot be achieved. In this occasion, it is reached to balance thanks to accommodation. Piaget mentioned about a natural motivation in the elimination of the status of mental disorder caused by the status of imbalance. It can be regarded as an emphasis on the learner-centered approach.
- Knowledge is subjective because people construct it.
- Cognitive development occurs step by step. Piaget says that as a result of maturation and experience children pass four stages of cognitive development. These are sensori-motor stage (0-2 years), preoperational stage (2-7 years) and concrete operational stage (6-12 years)[12,13,14,15,16,17,18,19].In preoperational stage, egocentric thinking and speech[10,11]are important properties put forward by Piaget. Accordingly, children in this stage cannot look events from another's point of view. According to this view, there is only one true and it is theirs.

THE CRITIQUES TO PIAGET

These views put forward by Piaget were criticized later in a number of aspects. Nevertheless Piaget's views are still evaluated and they are still the source of many studies. Piaget's views are still accepted. They are as follows:
- Children create their own cognitive structures.
- They have to associate the new experiences with the background knowledge for learning.
- They have to revise the meanings in case they come across confusing information – which don't comply with previous learning or cannot be explained with previous learning.

One of the important critiques about the processes, which the child can –can't do according to the stages of cognitive development. For instance, some studies have revealed that, in contrast to Piaget, many children in primary school have the ability of abstract thinking. Some other studies have revealed that experiences and knowledge may affect his logical thinking ability and, in the presence of experiences and enough information, it may appear earlier than Piaget's stages.

For example D. Field and Mayer revealed that four-year old children who are in preoperational stage can learn the law of conservation which can be learned in concrete operational stage according to Piaget when they interact with the people who are experienced and know the law of conservation well.

Another criticism against Piaget is about how an important effect that interacting with people has on learning and cognitive development.

Some studies have shown that some children who have physical disabilities can learn just from their observations without experimenting. On the contrary, some studies have shown that social interaction has much more effect on learning not only with peers but also with adults than Piaget realized. The importance of the social interaction will be examined in Lev Vygotsky's cognitive development theory.

Despite it is supported by some studies, many researches have expressed acute stages as softer than Piaget realized. Also they emphasized that Piaget could only anticipate how children may think but he

couldn't anticipate how they think. Some studies emphasize cognitive development is dependent on conditions, subject area and culture[20]. Lastly, di Sessa[21] said in his studies, knowledge, in contrast to Piaget, exists in the form of isolated pieces of information thus they cannot be explained in theories[22].

SOME SUGGESTIONS ON THE IMPLEMENTATION OF PIAGET'S COGNITIVE DEVELOPMENT THEORY

- Especially primary school students should be encouraged to play objects (do experiments) and to make discoveries.
- In cases student shows signs of egocentric thinking, one should pretend to be astonished and also it should be expressed that other people may have different thoughts. A common egocentric thinking and an appropriate response to it are illustrated:
- ✓ A child asks to his teacher: "What is this?" The teacher could not see the thing that the child is pointing. Therefore he demonstrates an egocentric thinking approach. Although the teacher can estimate what he is pointing to, he should say "what are you asking? I cannot see what you are looking to!" so the teacher should make him aware of different perspectives.
- The teacher should not be contented with the answers given by them, they should be asked to explain what consequences and how they have reached them. In addition, children's answers that do not make sense should be questioned by the teacher.
- Teachers should be sure that students have basic scientific skills required to complete the processes set as a target for them.
- Abstract ideas should be converted into concrete and observable events.

VYGOTSKY'S COGNITIVE DEVELOPMENT THEORY

Lev Vygotsky (1896-1934) made many studies dealing with children's thinking –children development, learning and teaching. Vygotsky's basic assumptions are compared here to Piaget's. Piaget emphasizes that despite cognitive development is mostly individual (individual constructivism), elder children make mental activities on their own. But Vygotsky believes that adults in a society let the children's cognitive development occur in a desired and systematic way (social constructivism). Adults put the children into activities strengthening them mentally and help them to achieve these activities. Vygotsky cares about spoken language. His theory is referred to as a socio-cultural approach because he, in cognitive development, emphasizes these terms through caring about society and culture.

- Adults, as a result of formal and informal communication, transfer the meanings-cultural values such as ideas, terms, terminology etc. - through language, symbols, math, art, literature and so on.
- In the early stages of childhood, thinking and language are quite dependent on each other. Vygotsky says that thinking and language are separate functions in early infancy period and thinking is not dependent on language. Language is first used as a means of communication by the child. Then, in addition the communication function the child begins to think with words. When he is about two years old and now thinking and language are associated with each other by him. In this stage, the child does self-talk-it includes an approach resembling to the explanations of Piaget's egocentrism- and he guides and directs his own behaviors. It is considered that this guidance is similar to the guidance that adults apply to themselves and it is thought to be inspired by them.
- Complicated mental processes begin with social interactions; as children develop, they internalize the processes they have used in social situations and begin to use them independently. Vygotsky emphasizes that many mental processes are acquired as a result of social interactions. As children talk and discuss about objects and events around them with wise adults, they learn about their society and world knowledge of adults' culture and they begin to use words, concepts, symbols and strategies that adults use. Not all mental processes develop thanks to interactions with adults; some of them develop thanks to their interactions with peers.
- Successful people's help let students reach difficult targets. Vygotsky mentions about two different skills. One of them is actual development level meaning the top level which children can succeed without help and the other one is potential development level meaning the top level

which children can reach with the help of a person who is at a higher level. To be able to truly define a child's development stage, both of his skills must be evaluated.

- The difficulties encountered in achieving the works contribute to the highest level of cognitive development. The works which a child could not succeed himself but could manage it with the help and guide of other people are defined as Proximal Development Zone (PDZ) by Vygotsky. At first, a child's PDZ includes his learning and problem solving abilities and naturally it develops as works are succeeded. Vygotsky says that he learns little from the works he could succeed on his own. On the contrary, development occurs only with the works which can be completed with the help of a more successful person. In other words, development occurs by achieving the works in the child's PDZ.

- Games, for children, aren't waste of time but rather they include activities that get them into adults' world successfully. Vygotsky emphasizes that a child sometimes behaves as if he was older and he says the changes in behaviors make them learn to plan the future, to think before act and to keep himself from some behaviors[23,24,25].

THE CRITIQUES TO VYGOTSKY

Some criticisms have been made on Vygotsky's views. Vygotsky focused on processes children developed rather than establish a relationship between their age and skills. On the other hand, it has been claimed that Vygotsky's descriptions of the development process are not clear and detailed. Therefore, Vygotsky's theory is considered as more difficult to test than Piaget's theory. But in spite of everything theorists and educators has benefited greatly from Vygotsky's ideas. The most utilized idea of Vygotsky is his emphasis on how culture affects cognitive development. Thus the transfer of society culture to new generations is guaranteed. Recently contemporary theorists emphasizes adults' help, named as social construction of meaning, children to make sense of their surroundings by sharing issues experienced by adults with children. In addition interaction between children is considered as an important approach to the explanations of their surroundings.

Contemporary theorists accept that correlation debates is of great importance in helping children to make sense of their physical, social and academic world. This idea is known as Social Constructivism. Following the discussions in this section, this idea will be given in a more detailed way in the next section.

Another issue that contemporary theorists are concerned with is cognitive tools such as terms, symbols, strategies etc. These tools comprise of abstract terms and they facilitate the daily life as other devices –knife, book etc. - do.

Contemporary theorists need to discuss variations what can be done to help children in reaching difficult objectives. The term mostly used for this help is supportive (scaffolding). This term was put forward by Bruner. Scaffolding is a support mechanism conducted to learner in reaching a target which is in his zone of proximal development. According to this mentality, when the child reaches the target without supporter, the support is reduced.

Another approach named as guided participation includes having children do the things which can be done by adults by constructing and supporting. In this process, it is important to make them familiar with the terms of adult world by using words such as hypothesis, evidence, theories, etc. consciously.

Another important term named apprenticeship -can be seen in many societies- ,in which a child and an adult interacts both formally and informally, contains an approach in which an adult teaches a child through a concept appropriate to child's ZPD to embroider, sew, play musical instruments, translate a text into a different language. As a result of this interaction, the child not only shows the related behavior but also learns to think about target skills. For example, children and adults work together to discuss how best to solve the problem or to achieve the target performance and they find the best approach. In this process the adult is a model for the child how best he can complete the process. Master-apprentice relationship comprises of six approaches. The first one is being model approach in

which the adult demonstrates how the process should be performed while the child is observing. The second one is master approach in which the child repeat the process, the adult assesses the child and gives feedback suggestions and clues when necessary. The third one is supportive approach in which the adult makes the process easier- for example he divides the process into steps. The fourth one is explanatory approach in which the learner informs the adult about the process by telling what, how and why he is doing. The fifth one is reflective approach in which the learner evaluates himself through adult's questions. The last one is discovery approach in which in case of succession the degree of difficulty in achieving the desired targets is being gradually increased and the adult allows the learner to draw the boundaries of application area of what is learned by self-regulating questions and problems. Although it seems difficult to implement it in the class, many theorists think adult-learner interaction essential in the acquisition of skills and the development of appropriate ideas related to different issues.

Finally, contemporary theorists emphasize peer interaction causes a different development from children's interaction with adults. Therefore, they emphasize the necessity of the peer interaction. Adults have been equipped more with knowledge and skills than children. In children's process of achieving the goals with their peers, it is possible to talk about four different benefits of their being in interaction. The first one is that debates about a problem or an issue allow the child to be aware of different perspectives about the subject and this generally provides a more holistic learning on the subject. Secondly, as debates contain disputes and conflicts, children internalize the process of discussing and gain the ability to look independently an issue at different perspectives in time. Thirdly, more challenging issues are achieved with peer support. Another benefit not emphasized so far is that children learn social behaviors such as planning processes to work together, impersonating different roles, etc. thanks to cognitive processes with their peers[26].

STRUCTURING KNOWLEDGE THROUGH SOCIAL PROCESSES (SOCIAL CONSTRUCTIVIST APPROACH)

Contemporary constructivists and educators whose numbers are growing gradually believe that when worked together the meaning is understood better than when worked alone. In social constructivism, while two or more people may have common knowledge structures. In the circumstance of structuring the information lonely, despite being in the same learning environment, two people have different information structures. The meaning sometimes can be constructed by multiple people at the same time, social construction takes weeks, months and even centuries. For example, by developing common terms, the formation of academic disciplines such as science, math, history, literature, music, etc. take centuries. At this point, the culture plays a major role in the process of knowledge construction. Because in order to communicate and explain the world –in other words, their experiences- different branches of science form different terms and principles for themselves. There are some important benefits of social constructivism approach listed below in learning a subject:
• Students openly express their own ideas, organize and defend them against others.
• Students are given the opportunity to learn deeply by extrapolating, setting up hypotheses and asking questions.
• Students are given the opportunity to meet other students who may learn the subject better and have different ideas.
• Students are given the opportunity to become aware of consistent and inconsistent information in their learning and complete the missing parts.
• Students are given the opportunity to realize that the explanations and ideas of other people having different cultural and ethnic backgrounds may be different and equally valid.

Other than the above-mentioned ones, there are different benefits of children interactions below:
• Peer discussions contribute to cognitive development.
• As a result of debates and controversies children gain concept, thinking skills and causality (reasoning) which they can use in their social interactions. In this process, they also gain the ability to look an issue at different perspectives through internalizing the process of discussing.
• They can develop more effective interpersonal skills.

- They can be a model to each other in thinking skills and academic approaches.
- During the debates and controversies among them, they gain the opportunity to learn and apply approaches used by scientists while they are defending their own ideas or emphasizing the strengths and weaknesses of an idea –for example by using evidences. Also they get the opportunity to realize that a series of ideas are required in order to obtain the knowledge and knowledge develops in time.
- Seeing the success of their peers may increase their self-confidence.
- Activities of learning that their social needs are met motivate students to participate in the learning activities.

Consequently, in social constructivism, during their regular and interactive studies on a topic, students gain too much in terms of not only the cognitive aspects but also the motivation for personal and social learning[27].

SOME SUGGESTIONS ON THE IMPLEMENTATION OF VYGOTSKY'S COGNITIVE DEVELOPMENT THEORY

- Students should be allowed to soliloquize and think aloud in the process of solving challenging problems. For instance, a student trying to remember sulfuric acid should be allowed to repeat a code prepared in advance.
- The cognitive tools should be prepared to simplify the challenging problems. For example preparing experimental apparatus can form a formula.
- Put forward problems, which students cannot achieve without help.
- In the process of solving challenging problems, students are supported until they can achieve on their own.
- Students are brought into small groups to work and succeed the challenging tasks.
- An ambiance is created for them to play the roles of adults. For example, they are given the chance of publishing a school newspaper and they are given the tasks of editor, caricaturist, photocopier, and distributor and so on.
- They should be given the opportunity to play adult roles through games[28,29].

INFORMATION PROCESSING THEORY

It is an approach appeared in 1950s and early 1960s and has developed since then. Initially, many information-processing theorists believed that humans contemplate like computer. But later, they realized that human thinking system is much more complicated. Nowadays, information processing theory which is alike to Piaget's and Vygotsky's approaches has constructivist approach: Children are active in the process of making sense of their world. Children cannot be considered as having the capability of storing the information in the external world such as a computer.

Information processing theory actually includes a range of processes in which children get the information, compare it to their prior learning and make sense of it, recall, change and use it. Many information-processing theorists reject Piaget's approach of developmental stages. According to them, children's cognitive processes and development of skills occur within the greater periods and in the form of slow changes. Also they say that children learn more quickly and remember more. There are some important properties of development in the theory of information processing below.

- Attention: Two approaches of cognitive development about a child's attention important.
- ✓ Distraction of children by unrelated things reduces in time. The situation that young children pay attention to things that they should not happens frequently but as they grow up, children gather attention better.
- ✓ What and how children learn depends on what they are intending to learn. Older children could learn and remember more things but it doesn't ensure that they have learned the right things.
- Learning strategies: Learning strategies can be defined as learning methods of significant and purposeful information. As children grow up, they develop some learning strategies to enable

them to learn and remember what they have learned. There are frequently observed approaches related to the development of learning strategies.

✓ Though doing over is not a successful approach in terms of learning and recalling processes, it is important in terms of short-term recall of the information. Not observed in pre-school, doing over develops in time (especially during primary school).

✓ Well-constructed information is easier to learn and the possibility of recalling it completely (as it is constructed) increases. Organization of knowledge develops in primary and secondary school stages. As children grow up, they construct information more frequently and effectively.

✓ Elaboration is a process which extends the new learning by applying learned information (experiences) to new ones thus there is much more learning than targeted before. Elaboration process is first observed in preschool stages and it keeps developing till adult stage. Elaboration process is a conscious strategy that allows children to learn and make sense of new information. Some studies have shown that only successful high school-level students try to use information including repetition to learn new information.

The organization of knowledge and elaboration processes are processes that clearly show the constructivist approach: Learner gets the information, rearranges it according to prior learning or adds it to prior learning and finally construct a meaning peculiar to him.

✓ Learning strategies become more effective as they grow up. When children first begin to use learning strategies, they use them less frequently, mostly ineffectively and by consuming more power. With time and usage, their ability to use learning strategies more quickly, more effectively and to use them in different matters develops.

• Knowledge: Children's knowledge on the basics of the subject and the world changes at least in two ways as they develop.

✓ Children's information evolving constantly facilitates their learning of new things. Children's information about the world develops over the years step by step in a limited way. The reason why adults and older children learn more easily than younger children is the increase of existing knowledge in years. Older children have more information than needed in understanding and elaborating new ideas and events. In case children have more information on a subject, they learn more easily than adults and older children.

✓ New connections are established among children's information in time. As emphasized before, older children are more successful in organization of new information and elaboration because both processes require the establishment of relation among terms and knowledge of older children, knowledge and terms of younger children are more isolated from each other. A reason why older children have information more connected and associated with each other is, as stressed by Piaget, may be that older ones make conclusions easily and have the ability of more logical thinking.

• Metacognition: people become aware of how they think and learn over the years. For example a person may realize that he can learn a text in a book only after reading it a couple of times or they will learn new information better and more meaningful if they use their prior learning to extend new information. Metacognition includes one's own cognitive processes, learning by using these processes effectively and consciously, and keeping metacognitive information in memory. As children develop, cognition knowledge and skills develop in the following ways:

✓ Children become aware of the limits of their memories in time. Children are generally too optimistic about their memory and they suppose that they can remember everything they have learned.

✓ As they get older, children realize that this is not the case. Children's skills to specify what they know and do not know advances in time. Though little children do not know enough to do something, they think that they have known and learned them. This situation prevents them from studying new information enough.

✓ Children learn much about effective learning strategies in time. As mentioned before, children use the strategies of repetition, organization and elaboration better in time. Besides, their awareness of in which situation which learning strategy is more successful increases depending on their experiences.

It should not be forgotten that students are not as effective as adults and teachers in teaching. Also it should not be forgotten that a range of factors – such as attention, motivation for learning, prior learning, awareness and usage of effective learning strategies – affecting learning skills develop slowly in school years. Adults and teachers should not expect students to learn as fast as them and to use the same strategies as they do.

Teachers should suggest to children what and how they should study and which strategy they should use. This suggestion is appropriate not only to Information Processing Theory but also to Vygotsky's view of how important adults are in children's learning (in their cognitive development)[30,31].

THE CRITIQUES TO INFORMATION PROCESSING THEORY

Information Processing Theory has been exposed to some criticisms by some other theorists. The first of them is that while Information Processing Theory explains the strategies children use in acquisition of new knowledge, it does not explain why they approach similar learning situations in different ways. The second one is Information Processing Theory has not emphasized much the effect of children's social and cultural diversity on cognitive development. Another important criticism is that it could not explain the reason of development of children's cognitive skills. In fact, this is a critique to not only information processing theorists but also Piaget and Vygotsky. Even if the theories on the development of the brain or for example the ideas of that much more complex learning strategies develop after working make recommendations about the development of cognitive skills, no theory could explain exactly how a newborn baby turns into a relatively specialized adult in terms of cognitive development.

Finally, in order to ensure children's cognitive development, all the theories must be well known and research results must be used well[32].

SOME SUGGESTIONS ON THE IMPLEMENTATION OF INFORMATION PROCESSING THEORY

- Especially in the education of little children, the things distracting children should be kept away. For instance, materials should be put away except for the materials being used during the experiment.
- Education should be based on students' prior learning.
- The implementation of learning strategies appropriate for the age being worked with and the subject being discussed increases students' success. Students should be encouraged to determine to use different learning strategies in different situations. For example, the teacher asks students "Now that, the population of the country changes in years, can we demonstrate it with a graphic?" (organization)
- Students should be given different assessment opportunities to check their own learning[33,34].

THE IMPLEMENTATION OF CONSTRUCTIVIST APPROACH IN CONCEPT LEARNING - MISCONCEPTIONS

Whether a person on his own as Piaget emphasized, or within the framework of social constructivism as Vygotsky emphasized or as emphasized in IPT, the process of structuring of knowledge in the mind could be developed through explaining with constructivism approaches.

In the process of meaning the environment, it could not be expected that the learned information is exactly the reality itself. For the rest, unrealistic learning may happen. As discussed before, many cognitive psychologists are against the idea that learning is just recording the reality in the environment in the mind in a simple way. According to them, learning includes a unique construction of information in the light of their experience. Different people infer different meanings (learning) from the same stimuli. One of the reasons for this is that each individual has come to the learning environment with their own experience and different knowledge. Except for the prior knowledge and experience, the fact that people have different expectations also affects their learning. If there were

an uncertainty in the new information, previously learned information and the expectations of the learner would affect especially the new learning because the information providing complete and accurate perception of the knowledge would not be reached at and new information is more prone to be affected by prejudices and expectations. In order to avoid misunderstandings, the information should not include uncertainties. However, the fact that learned information is different from the information which will be taught can be seen as a circumstance peculiar to every lesson in the school curriculum. Sometimes only some parts of the knowledge recalled from the long-term memory can be remembered. In this case, a restructuring process affected by recalled parts of the knowledge, expectations and other information may occur. This may result in the formation of some incorrect constructions. What should be done in terms of teaching is to facilitate the remembrance of the issue with its accurate details by making them pay attention to the important details of the process of coding.

Organization of Information
In the process of knowledge construction, information is organized in different ways at the same time, so information about each other occurs in the long-term memory. Some of this knowledge is concepts, schemas and theories.

Concepts
Concept is the way to categorize or group the interrelated objects and events. Concepts are at the heart of thoughts and some theorists think that the concepts are the smallest building blocks or units[35]. While many concepts are shared by different communities, others vary depending on the culture. As discussed in social constructivism, communication is facilitated by producing different concepts in different academic disciplines. Human beings have a tendency to organize objects and events around them in their mind and this tendency begins when they are three months[36]. A school-age child usually knows 8000-14000 words. Children learn thousands of different concepts at school. Concept learning sometimes takes place quickly but learning of some concepts takes long periods of time. In cases when concept learning takes long periods of time, concept adapts to new situations over time – Piaget's adaptation for the new situations. In the time between the concept is not known and it is completely known, a person knows the related concept partially in a missing and incomplete way. One of the most frequently encountered examples is children's assignments of the concept of animal – some children define the concept of animal just as four-legged, having fur and carrying her babies in the womb. Another example is that after learning the concept of rectangle, children describes square as a rectangle.

In some cases, students may do a low-level generalization of the concept. They implement the concept into a part of all objects or events covered by it. It is an example that a student does not classify insects, fish and birds as animals instead they take only mammals in the concept of animal. The above-mentioned situation of square-rectangle is an example of a low-level generalization. In some other cases, students may overgeneralize[37]. In case of overgeneralization, students suppose that an object and an event belong to a category which actually does not include them. For example, the fact that students include the words, you and I, into the category of name is a common example.

A concept is not accepted as fully learned if examples of covered or not covered by the concept are not learned. So it is important to provide a large number of samples not covered by the concept as well as samples covered by the concept.

As Piaget and other researchers emphasized, as children grow up, they begin to learn more abstract concepts[38]. This development has a positive effect on the learning concept. For example, while circle is initially perceived as something round by children, in the coming years, they can define it as a shape forming as a result of connecting points equidistant from a point. Similarly, while pre-school children define season of summer as a holiday, hot weather and sea, over time, they begin to define the concept of summer as a concept about settlements between the sun and the earth. Therefore, in order to learn abstract concepts, one needs formal education and to reach a certain age.

Connections between concepts

As discussed before, there are connections associating the information in the long-term memory with each other. Therefore, an important part of concept learning includes the formation of connections between concepts. In some cases, the concepts are connected with each other in a hierarchical manner. While the concept at the top this hierarchy is mostly abstract, the ones at the bottom of it mostly consist of concrete concepts. For example, the concept of vertebrate is an abstract concept and it is at the top of the hierarchy.

Piaget expresses that little children think a concept always belongs to only one category and they do not think they can place the concept in more than one category. Piaget says that children accept that a concept can belong to more than one concept only after concrete operational stage. In the new term holistic cognitive psychology, the fact that a concept can be given as an example of more than one category is not a product of an age-dependent skill but it develops as a result of formal education and it develops when children learn that multiple links with different characteristics can be established between different concepts.

The nature of the concepts

Theorists have different views about exactly what is learned about learning a concept. For example, some of them say properties list of the concept is learned, some say prototype is learned and some say that students learn the concept as a range of examples.

Properties list: some theorists say that as a result of learning a concept, examples of this concept are learned. For example, a person who has learned the concept of square learns the properties defining the square – it has four edges, angles between the edges are 90 degrees and so on. The more concrete and familiar the properties of the concept are, the easier it is learned. Children sometimes remember and use the properties including striking comparisons which are remembered easily, not the properties defining the concept they first met. For example, like the example given above, the reasons why children do not see the square as a rectangle may be that they could have seen the edge lengths of the rectangle in a different way and they could have drawn their attention more. This situation can be removed by giving many examples. In another example, children think - as animals-properties, which are defining the comparative properties about mammals and easy to remember, and creatures having fur, consuming food not producing instead of properties defining the animal. In terms of education, students should be taught what properties objects and events must have in order to be an example of the concept. On the other hand, properties defining the concept should be emphasized and it should be expressed that other comparative properties do not have the power to define the concept. Examples of the concept should be given and criticism should be made on them. Finally, it will be appropriate to encourage students to give different examples and make an evaluation.

*Concepts in the form of prototype:*learners create prototypes for many concepts in their minds. Prototype is a typical idea that the learner construct in his mind and it usually exists visually in the mind. Prototypes are examples of a concept which a person usually encounters. For example, when people hear the concept of "bird", many of them picture sparrows or pigeonsin their minds but few of them think penguins. After the learner has created a prototype in his mind, he compares new objects and events with this prototype and decides whether they are the examples of that concept or not. In the process of understanding, whether the new object or event is in the previous concept group, as the degree of similarities and differences between the old concept and new arrivals increases, the process of reaching the right decision will be easier.

*Concepts in the form of example group:*some concepts are constructed as the example group of a concept. This is because there are differences between the examples of the concept and the learner has to pay attention to them. For example, people think different fruits when they hear the concept of fruit. In this case, in order to understand whether the new object or event belongs to the related group concept or not, the learner will have learned much information to compare it with. One the

other hand, illustration process has to get more attention because these types of concepts need more and more examples.

Some Suggestions on Teaching Concepts
In the process of teaching a concept, steps given below are mostly applicable.
- The concept is defined.
- The properties defining the concept are introduced.
- It should be taken into consideration that comparative properties should not be emphasized and learners should not define such properties.
- The best example or prototype is given.
- Examples of the concept are given. Anderson[39] suggests that the examples of the concept should be given after the ones which are not the examples of it.
- Examples which are not of the concept, the ones most similar to the concept and the most confusing ones determined by researchers are especially emphasized.
- Evaluation studies, in which learners inquire whether a range of concepts belong to the related concept group or not, are made.
- Students are asked to give examples which are and are not related to the concept.
- The fact that connection can be established between different concepts is explained to the learners.

Schemas
A schema is a number of well-organized facts on an object or issue. Schemas are not just knowledge storages where information is organized. Schemas also take place in the process of explaining new knowledge. Sometimes schemas provide the completion of missing parts of the new knowledge. Schemas are different in diverse cultures. In terms of education, it must be ensured that one should have the necessary schemas for reaching the target set before education and in the absence of these schemas, they must be completed.

Theories
Long before children begin formal education, they have general belief systems -theories- about the world events. These theories include many concepts and the relationships between these concepts (for instance: comparatives, cause-and-effect relationships). When they become school-age children, they have developed some basic theories about their environment. Not only do these theories provide learning a concept but they also provide organizing and making sense of experiences and new information. For children are not in the guidance of adults or people who are more developed in terms of cognition, their first theories are named "naive"[40] and thus they include wrong beliefs and misconceptions.

Misconceptions
The fact that learners' knowledge they have constructed about the environment in their mind reflect the truth is not guaranteed. Beliefs which are not suitable to the explanations accepted by scientists are called as misconceptions (alternative concepts, alternative conceptual structures, theories and ideas not based on the experiences). Researchers have revealed that both adults and children have misconceptions. Students' misconceptions have many reasons. Most of these occur when they give meaning to their observations. For example when two events happen at the same time, learners sometimes consider them cause and effect. Society and culture can lead to the formation of misconceptions. For example, "the sunrise" and "the sunset" statements used in Turkish may result in the formation of the knowledge that the Sun revolves around the Earth. In addition, stories and cartoons may cause misconceptions. Sadly, students receive misconceptions from other people including teachers and the authors of the books.

No matter what the sources of the students' misconceptions are, they affect and disrupt new information. Meaningful learning and elaboration processes are important approaches in removing misconceptions. Ausubel explains meaningful learning by comparing it to learning by heart. As a result of learning by heart, knowledge is isolated from cognitive structure and therefore it may be disrupted

by prior or next learning. On the other hand, learned and recalled meaningful learning interacts with new information properly[41]. Besides preventing the formation of misconceptions, teachers should remove the misconceptions existing in children.

CONSTRUCTING THE KNOWLEDGE EFFECTIVELY

In the learning process, knowing that constructed information does not guarantee that education would be done properly. Cognitive psychologists recommend different ways to construct the knowledge effectively. Some of them are given below:

- Providing facilities for experimenting: first-hand experimenting with objects and creatures around them make learners explore properties and laws of the world. Teachers should give opportunities to students to learn by doing activities such as touching objects, playing with them, changing and combining them. Teachers generally have students make experiments step by step -a cookbook style- and thus they try to lead students to success. But it will be more helpful for students' cognitive development if they decide on -on their own- this method and when and which steps they take. Even in the cooking classes, students should have the chance to cook their own meals by using ingredients as they wish.

- Providing opportunities for consulting: it has been discussed before that two or more people can construct knowledge by studying together for some time. One's constructing knowledge by studying on his own is of great importance, but it is more important to provide students with opportunities for studying with teachers in the process of constructing knowledge. For instance, an experienced person who has already constructed the information on a subject contributes to the person who has got no information about the subject. This contribution, as Vygotsky emphasized, may occur when the learner gives names to the objects and events around him, determines the principles causing the events or explain the events.

- Emphasizing the importance of conceptual learning: learners sometimes have isolated information which they could not associate with each other. There is no doubt that when students learn the facts, concepts, and other ideas by associating them with each other in a holistic and meaningful way, their learning will be much more useful. In other words, the issues will be more useful if they are learned in a conceptual manner. It is much more important that students learn how the processes put forward the mathematical principles than learning mathematical processes by heart. It takes some time for a comprehensive and integrated construction. Many educators suggest "less is more" approach. Accordingly, few subjects will be learned better if they are studied in long periods[42,43]. Below are some suggestions for the achievement of conceptual learning.
  - ✓ Units should be based on basic ideas.
  - ✓ Each topic should be studied deeply.
  - ✓ New information should be associated with students' experiences and prior learning.
  - ✓ It should be shown openly that conceptual learning is more important than learning information in an isolated way by telling students, giving homework and using them as criterion in the evaluation process.
  - ✓ Students should teach their learning to others. This duty makes students focus on their learning more carefully and organize them better.

- Providing classroom conversations: it has been discussed before that when worked and interacted together, students learn better. Similarly, classroom conversations have an important contribution to students' learning. During these discussions, the teacher can get valuable information about students by observing them. For example, teachers can identify students' misconceptions in this process.

- Using authentic activities: as Vygotsky emphasized, children learn many things when they take part in activities appropriate to the conditions of real, cultural life in which they can interact with adults and more experienced people. Many holistic constructivists extending this idea say that children learn more useful, productive and integrated information through authentic activities in class- activities that they may encounter outside. For example, in language classes, children should be asked to write to real people instead of writing essays showing their only grammar skills. Especially at the beginning of the process, students may need support. Furthermore, authentic activities are also important as they put forward why the learning is learned. Thus,

students can be encouraged to learn by showing them that they can use their learning in their future life. In addition, students' knowledge and skills are also assessed through authentic activities.

- Creating learning-centered classroom: psychologists and educators considering the advantages of creating a constructivist classroom environment with interaction between students emphasizes that it is beneficial to create a learning-centered classroom where the teacher and students help each other to learn by studying together. Such a class has the following characteristics:
  - ✓ All the students are active.
  - ✓ Interactions between two or more students are often experienced and such interactions are considered as important.
  - ✓ Differences in students are tolerated and respect between them is valued.
  - ✓ Teachers and students help each other to learn by working in coordination but nobody has dominance to have special privilege in others' learning.
  - ✓ Every individual is a potential source for others. Different students may be the "expert" of different topics.
  - ✓ The teacher guides and directs the class activities but students can show these features.
  - ✓ Students regularly evaluate others.
  - ✓ The process of learning is emphasized as well as learning product.

On the other hand, it is worth mentioning to weak points of the approach of creating learning-centered classroom. In the approach of learning-centered classroom, a student's learning is limited to his own learning and others' learning in the classroom. There is a high risk that students may transfer their misconceptions to others in the classroom.

Correcting Misconceptions

Any information given on a subject in the classroom does not guarantee to remove the students' misconceptions on that subject and replace it with the right information the teacher have given. Researches with a range of age show that even the educations, organized in order to eliminate misconceptions, do not eliminate the misconceptions. Below are theorists' estimation about why misconceptions is so resistant to change:

- Existent beliefs affect the explanation of new information: the learners describe the new information dependently on their prior learning. This means that they continue to believe what they have believed until that time. This is an approach applied naturally for elaboration and meaningful learning.
- Preference for self-validation: many students tend to find information validating his prior learning and to ignore or consider others as worthless.
- Misconceptions can be supported by daily life: scientifically-learned information can be "not applicable" in daily life. For example, metals –although good heat conductors- are used in making flasks.
- Some concepts (misconceptions) are so integrated with many theories and concepts with close connections: in this case, eliminating some misconceptions require changing many well-organized schemas, not destroying a single belief.
- Students may not realize that their existent knowledge and new information are different although they are different: this may be because students learn information by heart and they do not organize and associate them with their other information well.
- Students may be connected to their existent information personally or emotionally: in some cases, the student rejects the right information (accepted scientifically) as he thinks that it is against his culture, religious beliefs or his ego.

The more the number of students' misconceptions, the more difficult to provide them to learn theories. In terms of education, not only do the learners need to learn the new information but also they need to eliminate the information and theories not accepted scientifically. In other words, teachers should have students make concept corrections.

Some Strategies for Correcting Misconceptions

There are different strategies to eliminate the misconceptions. Eliminating some of the conceptions may need multiple strategies. Below are some strategies applicable in eliminating misconceptions:

- Misconceptions existing before education are determined.
- Students should be convinced that their existent information is insufficient. In order to provide conceptual change, students should realize that their information is incorrect or insufficient. In Piaget's words, the state of imbalance must occur first in children. In this process, demonstration experiments[44], experiments conducted by students, teachers' descriptions and student discussions can be used.
- Students are motivated to learn scientific information.
- It should be done in a respectful manner while proving students that their information is insufficient. The students should not be afraid that he would be mocked.
- It should be determined why students insist on misconceptions by observing them and then a strategy should be developed to eliminate this cause.
- In accordance with the constructivist approach, students should be exposed to the situations surprising them and therefore they are obliged to assess their prior learning, revise them and look at them critically. However, this approach does not mean that the newly learned knowledge to be accepted as unquestionably right. It should be ensured that the new information is obtained through scientific methods.

In spite of all these proposal of strategies, the most important principle which should always be kept in mind is that: construction or re-construction after teaching is carried out by the learner himself. In other words, cognitive processes (meaningful learning, organization, elaboration, etc.) depend on the person himself[45,46,47,48,49].

SUMMARY

- ✓ Cognition includes acquisition and usage of the knowledge.
- ✓ Humans have the opportunity to choose what and how they process and learn in their mind.
- ✓ Cognitive processes affect what and how is learned.
- ✓ Knowledge is not acquired directly from the environment; instead it is constructed by the learner.
- ✓ Prior learning and beliefs affect how people construct the knowledge in their mind.
- ✓ People participate in their own learning processes in an active way.
- ✓ Knowledge, in Piaget's words, is constructed in schemas and after new learning these schemas are organized and developed better and new connections are established between them.
- ✓ According to Piaget, learning and cognitive development occur with assimilation and accommodation processes which are completing each other.
- ✓ Vygotsky believes that adults in a society provide the cognitive development of children in a desired and systematic way. (social constructivism)
- ✓ According to Vygotsky, it is important that adults put the children into meaningful activities which strengthen them mentally and help them to succeed these activities.
- ✓ Social Constructivist Theory emphasizes that when worked together the meaning is understood better than when worked alone.
- ✓ Constructivist theories support or reject each other in some ways but if they all were analyzed together, one could learn important information about cognitive development and learning.
- ✓ Today, information processing theorists have a constructivist approach resembling to Piaget's and Vygotsky's approaches.
- ✓ Information processing theory includes a range of processes in which the learner get the information, make sense of it by comparing it to his prior learning, recall, change and use it.
- ✓ Constructivist approach is applicable to education.
- ✓ Constructivist approach can be applied in concept learning in terms of constructing knowledge. It explains the formation of misconceptions and includes useful information about the prevention of misconceptions.

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