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A CONCEPTUAL FRAMEWORK IN THE UNDERSTANDING OF SCIENCE EDUCATION

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Abstract

The purpose of this study was to create a conceptual awareness in science education for accurate observation of what is happening around us. To correctly understand the conceptual framework of the curriculum currently being implemented and to make us aware of our need to know how to put this framework into practice will serve as a guide for carrying out programs and for improving them. In this context answers are being sought to the questions; what kind of contents, what kind of teacher, what kind of teaching, and, what kind of evaluation, are necessary for the implementation of a constructivist approach that is appropriate for teaching science lessons in our educational culture. Students in primary schools and teachers of the future in the education faculty are, both, seeking answers to these questions with classroom experiences from the viewpoint of student and teacher. As a result educational programs that are similar to our education and that are in place in many countries throughout the world have acquired integrated concepts and terminology. At the conclusion of the study a framework was prepared that will proceed from the "native language integrated with scientific language is the basis of science culture" approach in science educational activities, and will create the foundation of a collective shared approach in the perception of the conceptual contents and procedures of new programs.

Key words: science education, constructivist approach, scientific language

Introduction

In our examination of societies with developed economies and high quality of life we discover that the workforce has the same qualities that run the system and take advantage of these in the background. An accumulation of workforce with these qualifications can only be obtained by the careful attention to the education of every individual in these societies. The earlier in their lives that these efforts are exerted the greater the effect it will have on outcomes. Because an individual's perception and conceptual abilities are directly related to the contents of the education that is given, the methodology and the individual's cognitive development, which is the subject for discussion, are important in these efforts. For this reason the roles of all of the people who have roles in determining and implementing the contents of science education that lays the foundation at an early age need to be correctly defined. This will only be possible when there is agreement on a shared language and approach in the methodology and concepts that are used in science education activities.

Science education curricula which are revised according to primarily educational research results are adjusted with very small changes and over time these create a set of problems. The greatest problems are experienced in adapting new concepts to our language and the completing of its contents. In this context answers are being sought to the questions; what kind of contents, what kind of teacher, what kind of teaching, and what kind of evaluation are necessary for the implementation of reconstruction approach that is appropriate for teaching science lessons in our educational culture. Students in primary schools and teachers of the future in the education faculty are both seeking answers to these questions with classroom experiences from the viewpoint of student and teacher. As a result educational programs that are similar to our education and that are in place in many countries throughout the world have adopted integrated concepts and terminology.

The Ministry of Education conducted a very rapid and narrow frameworked pilot study then made changes in the primary school curriculum and put them into practice. The program is consistent conceptually with the philosophy of science education projects being implemented throughout the world. In fact there are many activities in curricula that were created from activities developed within the framework of "science education" in different countries. However we have not been able to make much progress on training teachers who will be able to systematically serve as guides in implementing the inquiry-based approach for these activities. In short our teachers do not have the maturity to adjust to these changes. No matter how much the Higher Education Authority education faculty makes significant changes in teacher training programs inclusive of the revised "hands on" project, it has not created harmony and coordination between the curriculum, teachers and education faculty programs. It does not appear that it will do so in the near future either. In addition to all of this since 2002 TUBA's "Science Education Project" (TUBA, 2002) interventions have been very positive developments from a scientific understanding, but they also need to distribute it in a planned and prudent manner.

At the same time Yves Quéré, one of the leaders of the "Science Education Project" (La main à la pâte--hands on) in France, a French physicist and member of the French Scientific Academy, came as a special guest of TUBA and gave a series of lectures in Ankara and Istanbul April 17-20, 2007. He met with the Education Minister and other authorities. In an interview conducted with Quéré (Yuzak, 2007) the answers he gave to questions were striking to us as education faculty members. The questions were universal and we think the solutions can be found quickly but they tell us that they can only be found with systematic effort.

The answers Quéré gave to Yuzak’s questions were these:
— Yüzak: Are there important duties here for **trainers** or **teachers**?
— Quéré: In fact maybe this is the **most important difficulty**, because creating a physical experimental environment does not require a lot of materials. The main problem is with teachers. The classic system is easy for teachers. It is easier to explain a subject from a book and to implement a question-answer system limited to that. For the important ones, the teachers, to be able to do an accurate and good implementation of the "Hands On" program they need to be trained. As in every other country France also experienced difficulty in this area. In fact teachers are afraid to teach students science in this way.
— **Yüzak:** So how is this problem overcome?
— **Quéré: By creating a mechanism for training teachers.** The French Scientists Academy received significant support on this subject. Of course we should not forget the other actors. One of the Academy's most important partners in this project has been the Ministry of Education. The "Hands On" project began in 1996 with a ministerial decision. The project was started with 450 primary school teachers in five different regions of France. Another of the institutions in the partnership was the Education Faculty (IUFM: Instituts Universitaires de Formation des Maîtres). Also action was taken in coordination with the National Pedagologic Research Center (INRP: Institut National de Recherche Pédagogique). In addition an internet website facilitated teachers being able to communicate with each other about the "Hands On" project as well as follow studies on this subject in other parts of the world.

The starting point for use is to correctly observe what happens around us, to create an awareness of these developments in teachers, and to become aware of what kind of agreement we need to have to understand and implement our current curriculum in the best way. In this context we will consider this change under four basic headings and seek the answers to the following questions.

1. What kind of contents?
2. What kind of teacher?
3. What kind of teaching?
4. What kind of evaluation?

If we can give the correct answer to these four questions we think we can take the right steps in carrying out the programs and in improving them.

1. What kind of contents? – “Simple - Complex Science”

To accurately understand and interpret the world in which we find ourselves we must first correctly perceive it. What is meant by correct perception is to be able to systematically look at events and make connections. However, it is very difficult to systematically perceive all of the things that happen around us, particularly in childhood. This does not mean that we cannot accurately perceive the world in childhood or that it is not necessary to strive for this. In particular, the efforts we make at these ages are the key to a love of science in later years. If we can make students at that age understand how to think scientifically it will enlarge their imagination of the world and it will be make it easier for them to become inquisitive individuals. To approach the physical world in which we find ourselves we can simplify its complex structure without destroying its essence with experimental activities. What is explained simply here is carrying out scientific activities with everyday materials. That is, materials and experimental activities that are planned from simple things. For example we can teach the lifting power of water with a tangerine and a bowl of water. Simplicity helps us to think correctly and also helps us to make connections between events. Thus students will be saved from their prejudice that "science is difficult" and discover the place that science has in our lives. Here the essence of simplicity is that it helps students get closer to perceiving and understanding complex events. This simplifying is not in opposition to the nature of science. Because "there is an absolute continuity between scientific facts (at the foundation) and scientific peaks" if we consider science at the peaks as fantastic telescopes, genes, neutral proteins we will be able to find complex science, but if we consider them at the level of physical reality (at the foundation) we can touch and feel them ... and we can help children approach the perceptual and conceptual world (Quéré, 2006).

At an early age, science education is a process that moves between games and experiments. At this stage we make the transition from a systematic consciousness of games with rules to the skills of scientific thinking with rules. Observing, inquiring, forming hypotheses, experimenting, testing activities and discussing verbally and sharing these with others, and being able to accurately report all these processes are necessary for carrying out scientific thinking and the skills of the scientific process. The trend in scientific thinking is to find beauty along the pathway. It is inquiring, discovering, observing and trying to find things like a scientist. It is forming bridges between the mind and senses in the physical world. The most realistic way to do this is to participate. The basis of this participation will also draw us closer to the complex world and help us discover simple paths. This is why it is necessary for these activities at the foundation of science education to be formed for this simplistic approach at an early age.

2. What kind of teacher? - "Systematic Guidance"

Everyone feels like they have the right to voice their opinion whether they are a specialist in the teaching profession or not. Perhaps for this reason, many people who have gone through the educational process feel like they have the experience to speak out. However, today the characteristics of the teaching profession are being discussed according to the virtual reconstruction approach. With what kind of teacher can students create their own knowledge model within the process? What does the teacher need to model that will help students acquire the skills of active thinking?

Concepts begin to be formed in the early years of childhood, but the process of intellectual dimensions, such as perfecting, improving and shaping, takes place in later years. So, for this reason during the learning process, connections need to be made between new information and previous information and experiences. Teachers today work hard to find opportunities for students to develop their own knowledge with experimental, examination and discovery based work. According to current educational theories for students to be able to understand a subject they have to have a guide to form their own ideas. At every stage of science education a guide can help a student successfully interpret newly acquired information, can facilitate students' storage of information in their memory, and can help them organize this information. So this guide is none other than the science teacher. In that case even if some people in the Turkish educational system see the virtual reconstruction approach as recommending that "the students teach themselves." The role of the teacher is more risky and difficult than in the classic teaching approach. Consequently, if a teacher who is not equipped in the virtual reconstruction approach tried to teach a class accustomed to this virtual reconstruction approach without reconstructing the information it would lead to confusion and mistaken concepts.

Now let's discuss what the model teacher is and what characteristics the teacher, whom we have called a "systematic guide" in the virtual reconstruction approach, needs to have. In particular the systematic guide needs to be equipped, both, in the area of pedagogy as well as knowledge in the field of science. In this context, the role of the teacher who is a guide to learning is not the role of an observer. We are talking about a systematic guidance teacher who will analyze the students' learning styles, who is equipped with the knowledge, skills and research techniques to be able to measure differences and similarities, who designs and guides activities that will include scientific processes, who has students ask questions, form hypotheses, gives importance to the accumulation of scientific reasoning that accompanies experimental observation, who creates solutions to problems, and who can open new horizons of curiosity in the minds of students. This is not one of information transfer, but as guide, tutor, and mentor who points the way and builds bridges between pieces of information with systematic guidance. In addition to this, the process in systematic guidance is very important. This process is one that is based on succession and observation that forms stages of preparation, implementation and evaluation. Systematic guidance prepares classroom practice, and in particular he/she does this him/herself, then has students do it in class in light of the scientific thinking process mentioned above and finally also evaluates the students. The process has not yet been completed. The most important stage of systematic guidance begins here. After evaluation, the students' incorrect concepts are determined and additional activities are planned based on these to try to correct them. In other words the process is ongoing and needs to be completely equipped. This then is the appropriate teacher model, the systematic guide, for the virtual reconstruction approach.

3. **What kind of instruction? –**“C**onstructivist in the sense of Cognitive, Participative in the sense of Pedagogy”**

The revised curriculum was prepared within the philosophical framework that is constructivist in the sense of cognitive, and participative in the sense of pedagogy. For this reason, to search for concrete/practice constructivist would lead us down the wrong path. It is particularly important to create this awareness in teachers. On the other hand, in basically participative pedagogic activities the only two methods of science are ensuring a flow of experimental and observable physical facts to the participant. These methods can only be carried out in a collaboration of mind and sense activities. There should be separate philosophies in the experiments and observations carried out within these activities, because they have different epistemologies. In this context, the experimental instruction has the philosophy of “**You try, too**”. The goal is to ensure that everyone participates in doing and experiencing the experiment.

However, the philosophy adopted in observation is “**I am observing with my senses**”. That is, observation activities are planned so that all senses are included. Although the word, “to observe” suggests vision today it needs to be interpreted to mean perceiving by directly or indirectly interacting with something. It has many actions related to our senses being systematically directed with cognitive abilities. Let me explain with an observation activity conducted with a fifth grade student. The fifth grade student who is asked to make an observation in a completely dark room is not able to make any comment about the dark room at the end of the observation because he says he could not see anything. Then the students are told that observation is, in fact, made with our five sensory organs, that we usually use more than one sensory organ to test the accuracy of data from things with which we come in contact, that we touch something that we can see when we are buying something in a store, and even need to smell it sometimes, we are drawn to the source of something that smells nice from a distance, and we are curious about who is speaking with a pleasant voice and want to look.... And most of the time our observations are discussed in class directly or indirectly in relationship to our sensory organs. Then the student goes into the dark room again and his observational experience is changed from the previous observational experience and enriched. The student begins to guess that the place he is observing is full of things because sound does not make any echo at all, that there are some hard objects around him and that he smells different things around him and can even begin to guess what they are. Here the systematic guidance that occurs is nothing more than drawing out concepts, experience and skills which exist naturally in the student. For discovering what is happening around us, to look and examine details, to use all senses in harmony, to question, examine, think, determine differences, to discover repetitive structures and events, to make shapes with our pens and in our minds with what we perceive, to share, to look behind what is seen, to unify all of these pieces explains one who uses the philosophy, "**I am observing with my senses**". Most of the time, experiment and observation can be used in a process of order. Both methods must be consistent with scientific processes.

Most of the time experiment and observation are both activities that fulfill the "You try, too" and "I am observing with my senses" philosophies. In fact we can say that you cannot have an experimental activity without observation. However, an observation activity can be carried out independently of an experiment. Experiment and observation need to be included within each other under the umbrella of an activity.

Students (La Rénovation de l'enseignement des Sciences et de la Technologie à l'école , 2000)**:**

1. Observe events and formulate questions for interrogation,
2. Imagine, carry out experiments and take notes,
3. Share ideas with each other, argue to support their ideas, compare the results of experiments, make verbal and written reports of the results,
4. Interpret the observations and results of experiments in the framework of current scientific knowledge,
5. Respect the opinions of others and learn to listen in response.

When all of this is done, correct use of the language, being inquisitive, suspicious, skill of critiquing, autonomy, respect for other opinions....these are using critical mental and linguistic skills that we want and expect them to develop during activities.

4. What kind of evaluation? – "Learning Outcomes"

Evaluation is an important stage in science education which requires continuity. The logic of evaluation today is more often stated with the concept of "learning outcomes". Learning outcomes are the competencies of what the student knows and what the student can understand (Tuning Educational Structures in Europe, 2007). Here competency information is a combination of concepts and skills. Learning outcomes need an active, observable and measurable process that changes directly from teaching to learning. To do this they must be a combination of the shared philosophy that is taught.

In light of what was explained above, the knowledge, skill and methods anticipated to be achieved in the science education activity as parallel with the curriculum are presented as terms, definitions and recommendations in the items below. These items are classroom activities that will be done with future teachers in the education faculty and students in primary schools. During a science activity the order of these items is not important but it is important to remember them and keep them in mind.

1. All scientific activities need to start with **inquiry**.
2. Our activities need to be designed and carried out with the philosophies as cognitive "**constructivist"**, and as "**participative"**(La main à la pâte , 2007**)** in practice.
3. Our basic point of action in experiments is "**You try, too**", in observation is "**I am observing with my senses**".
4. We need to use **scientific process skills** in our experiments and observations.
5. Without a **theoretical framework** experiments and observations are not meaningful.
6. We need to be alert for students' **misconceptions** during experiments and observations.
7. The teaching and learning process needs to be **student-centered**.
8. We can make the world in which we live in the laboratory/classroom environment meaningful: we can explain many **complex phenomena with simple materials**.
9. **Student participation** in the basis of experimental and observational activities. The teacher is the participation assistant, the **teacher** is in the position of **systematic guide**.
10. All activities related to **science education** must be **systematic** before class, during class and after class.
11. The teacher has primary responsibility for "**knowledge of the area**" in the activity.
12. It is important to use **time** well in our activities.
13. **Cognitive and perceptive** activities strengthen learning.
14. Subjects taught need to be related to **daily life**.
15. We should never forget that **we are responsible** for the **natural environment**.
16. It is important for us to have a **scientific culture** and make those around us **aware** of this subject. We should not forget our own **responsibility** on this subject.
17. The **variety of mental exercises** are important to our activities.
18. Teachers need to carry out activities themselves first before implementing the **first you try** philosophy.
19. Observations and experiments and the ideas generated with them need to be shared, discussed and the results need to be reported.
20. First the learning activity process is evaluated then the characteristic in the tasks of the activity processes
21. Care needs to be taken that Turkish is used correctly for the productivity of sharing in activities. The native language and the combined scientific language are the foundation of the scientific culture.

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