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EXPERIENTIAL LEARNING: THE ROCK CYCLE IN A WORKSHOP - PRESENTATION AND EVALUATION OF THE TEACHING APPROACH

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Abstract

A research organised in the frame of the European project GEOschools to investigate the interest of students and teachers in geosciences in secondary school, concluded that both students and teachers are deeply interested, among other things, in the teaching strategies applied to teaching Geology. Bearing this in mind, a workshop was designed about the rock cycle, simulating the natural processes that take place in earth's lithosphere, using everyday objects. The workshop was then carried out with the help of students and/or teachers of secondary school who evaluated the whole endeavour in terms of efficiency in imparting knowledge and acquisition of a deeper understanding of otherwise difficult concepts through evaluation sheets.
Keywords: *geology teaching, secondary school, simulation of natural processes.*

Περίληψη

Η έρευνα η οποία διεξήχθη στα πλαίσια του Ευρωπαϊκού προγράμματος GEOschools για να διερευνηθεί το ενδιαφέρον μαθητών και καθηγητών όσον αφορά στις Γεωεπιστήμες στη Δευτεροβάθμια εκπαίδευση, κατέληξε στο συμπέρασμα ότι οι μαθητές και οι καθηγητές έδειξαν έντονο ενδιαφέρον και για τις στρατηγικές διδασκαλίας οι οποίες εφαρμόζονται στη διδασκαλία της Γεωλογίας. Έχοντας το συγκεκριμένο γεγονός υπ' όψη, σχεδιάστηκε το εργαστήριο για τον Κύκλο των Πετρωμάτων, με προσομοιώσεις των φυσικών διεργασιών με τη χρήση καθημερινών αντικειμένων. Το εργαστήρι πραγματοποιήθηκε με τη βοήθεια μαθητών ή/και εκπαιδευτικών οι οποίοι αξιολόγησαν το εγχείρημα με βάση την αποτελεσματικότητα στη μετάδοση γνώσης και την απόκτηση βαθύτερης κατανόησης σε μάλλον δυσνόητες έννοιες, μέσα από φύλλα αξιολόγησης.
Λέξεις κλειδιά: *διδακτική της Γεωλογίας, δευτεροβάθμια εκπαίδευση, προσομοιώσεις των φυσικών διεργασιών.*

1. Introduction

The research which was carried out in the course of the GEOschools project regarding the interests of students and teachers as far as Geoscience teaching is concerned, concluded that the way Earth sciences were taught was of upmost importance. Students and teachers alike expressed a great interest in the teaching techniques applied when it comes to teaching Geosciences. The workshop called «Rocks: we are born, we live, we change but do we die? The cycle of our lives» or «Cooking with Rocks» was designed on the principles of Experiential Learning Theory (ELT) (Kolb, 1984)

using various teaching approaches and was carried out involving teachers of secondary schools and high school students. The evaluation comments we received from the participants revealed the power of such techniques on the course of the learning process as well as their weaknesses.

2. Experiential Learning Theory

The topic of how learning is achieved has been the object of study and speculation over the years and has received considerable attention in educational and neurological areas. Experiential Learning Theory draws on the work of prominent 20th century scholars who gave experience a central role in their theories of human learning and development – notably John Dewey, Kurt Lewin, Jean Piaget, Carl Jung and others – to develop a dynamic, holistic model of the process of learning from experience. It is a holistic theory that defines learning as a major process of human adaptation involving the whole person. The process of learning from experience is ubiquitous, present in human activity everywhere, all the time. The term Experiential Learning is a broad term, generally used by educators to describe a series of pragmatic activities sequenced in such a way that is thought to enhance the educational experience for the student learner. Literature related to this topic has revealed that scholars in the field of experiential learning have used this term in two different but related contexts (Smith, 2001; Brookfield, 1983). The first context, as Smith (2001) described it is the «sort of learning undertaken by students who are given the chance to acquire and apply knowledge, skills and feelings in an immediate and relevant setting» and requires the involvement of an educator. An experiential educator's role is to organize and facilitate *direct experiences of phenomena* under the assumption that this will lead to genuine, meaningful and long-lasting learning. It involves a direct experiential encounter with the learning event rather than simply a thought process associated with the learning (Borzak, 1981) (figure1). This direct encounter with a learning event requires active engagement of the student as opposed to passive engagement commonly associated with teacher directed instruction that generally results in minimal student interaction in the learning process. The second context of experiential learning described in the literature addresses student's reflection on direct participation and direct encounters within the events of everyday life and might be called «nature's way of learning » (Houle, 1980) (figure 2). John Dewey (1859, 1952) believed that learning was an active process and that students should be involved in real-life tasks and challenges. He had a gift for suggesting activities that captured the centre of what his classes were studying. His philosophy helped forward the progressive education movement and spawned the development of experiential education programs and experiments. Experiential Learning Theory (ELT) has steadily gained acceptance and popularity in education and serves as an invaluable resource for teaching and learning (Kolb and Kolb, 2006). Kolb draws upon the works of Dewey and formed an experiential learning model build on six propositions (Kolb and Kolb, 2005), which are as follows:

Learning is best conceived as process, not in terms of outcomes. The primary focus on education should be on engaging students in a process that best enhances their learning. «…education must be conceived as a continuing reconstruction of experience:..the process and goal of education are one and the same thing» (Dewey, 1897).

All learning is re-learning. Learning is best facilitated by a process that draws out the students' beliefs and ideas about a topic so that they can be examined, tested and integrated with new, more refined ideas.

Learning requires the resolution of conflicts between dialectically opposed modes of adaptation to the world. Conflict, differences and disagreement are what drive the learning process.

Learning is a holistic process of adaptation. It is not just the result of cognition but involves the integrated functioning of the total person – thinking, feeling, perceiving and behaving.

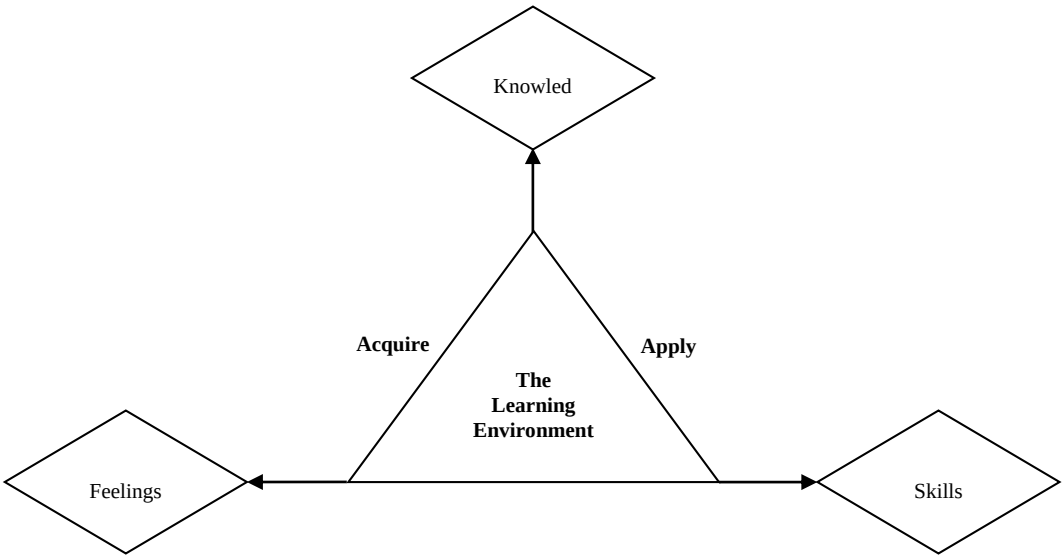

Figure 1 - Experiential learning via a direct educational encounter (Borzak, 1981).

It encompasses other specialized models of adaptation from the scientific method to problems solving, decision making and creativity.

Learning results from synergetic transactions between the person and the environment. Stable and enduring patterns of human learning arise from consistent patterns of transaction between the environment and the individual. People create themselves through the choice of actual occasions they live through.

Learning is the process of creating knowledge. ELT proposes a constructivist theory of learning. This stands in contrast to the «transmission» model on which much current educational practice is based where pre-existing ideas are imparted to the learner.

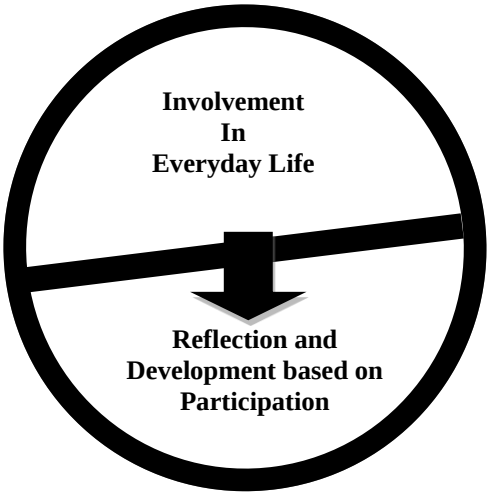

Figure 2 - Experiential learning throughout Life (Houle, 1980).

2.1 The cycle of Experiential Learning

ELT defines learning as «the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience» (Kolb, 1984). The ELT model portrays two dialectically related modes of grasping experience - Concrete Experience (CE) and Abstract Conceptualization (AC) and two dialectically related modes of transforming experience - Reflective Observation (RO) and Active Experimentation (AE). Experiential Learning is a process of constructing knowledge that involves a creative tension among the four learning modes that is responsive to contextual demands. This is portrayed as an idealized learning cycle or spiral where the learner «touches all the bases» - experiencing, reflecting, thinking and acting – in a recursive process that is responsive to the learning situation and what is being learnt. Immediate or concrete experiences are the basis for observations and reflections. These reflections are assimilated and distilled into abstract concepts from which new implications for action can be drawn. These implications can be actively tested and serve as guides in creating new experiences. Kolb and Fry (1975) asserted that the learning process can begin for students at any one of the four modes and should be viewed as a continuous cycle (Figure3).

While Kolb and Fry state that, Smith (2001) states that: The learning process often begins with a person carrying out a particular action and then seeing the effect of the action in this situation. Following this, the second step is to understand effects in the particular instance so that if the same action was taken in the same circumstances, it would be possible to anticipate what would follow from the action. In this pattern the third step would be to understand the general principle or conceptual framework under which the particular instance falls.

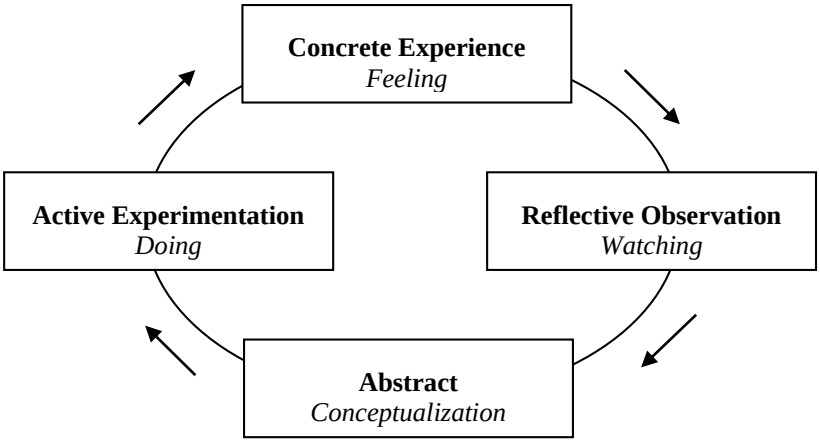

Figure 3 - The four modes of Kolb's Experiential Learning Cycle (Kolb and Fry, 1975).

3. Materials and Methods

The workshop was designed according to the principles of Experiential Learning. A variety of teaching methods were applied so as to lead to the maximum involvement of the learners – may they be students or teachers. The initial planning was based on the jigsaw puzzle teaching technique (Aronson and Patnoe, 2011) with the participants splitting into 5 random groups, each one dealing with a different area of related context which had been chosen in advance. After processing the newly acquired information, they are asked to form 4 new, larger mixed groups. Each new group consists of five members, each one coming from a different group, so that the newly formed groups can be briefed on all the topics that were discussed in the initial ones. Each different topic is presented to the new group by the representative of the former group, so the learner plays an active

role in the teaching process. Then all the information is combined and it is presented in four different ways.

During the first stage a variety of teaching methods are applied so as to enable the learners to assimilate the knowledge provided (Fermeli and Dermitzakis, 2008). Team collaboration is the first step, *group discussion* is an integral part of the process, some *experiments* are also conducted and a lot of *simulations*. Everyday objects are used by the participants to simulate the natural phenomena which take place in the Earth's crust and deeper. The discovery of knowledge is guided by the pre - designed activities that the learners are asked to perform. At some point *the pre - existing ideas* of participants are written down followed by the edification of new knowledge. *Concept maps* are also completed by each group. During the synthesis stage, the participants are asked to write a story or a poem, using the new information. They are also asked to draw something relevant or make a collage illustrating some of the new knowledge acquired.

The whole workshop was designed on a «learning by doing» basis. Some of the imaginative everyday objects that are used are: a watering pot, a hair dryer and a hammer to simulate the process of erosion and weathering. The sedimentation is presented using rounded sweets, sugar, flour and honey. The formation of metamorphic rocks is simulated with the use of a toaster where the «sweet» sedimentary rock changes under the heat and pressure applied by the toaster. As for the igneous rocks, sugar and water form crystals, just like the ones formed during the slow cooling of magma.

4. Design and Presentation

GEOschools is a European project which was carried out from 2010 up to 2014. The findings of this project initiated the planning of several different, complete, model teaching precedures, as they suggested that students and teachers alike are deeply interested in the teaching techniques applied to teaching Geology (Fermeli *et al*., 2012-fig. 4) and one of their mostly preferred topic is the rock cycle (Fermeli *et al*.,2012, 2014). The workshop «Rocks: we are born, we live, we change but do we die? The cycle of our lives» or «Cooking with Rocks» was designed and presented for the first time to teachers of Secondary schools in the 3rd GEOschools International Conference that took place in Athens, in September 2012 and has been presented on several occasions ever since.

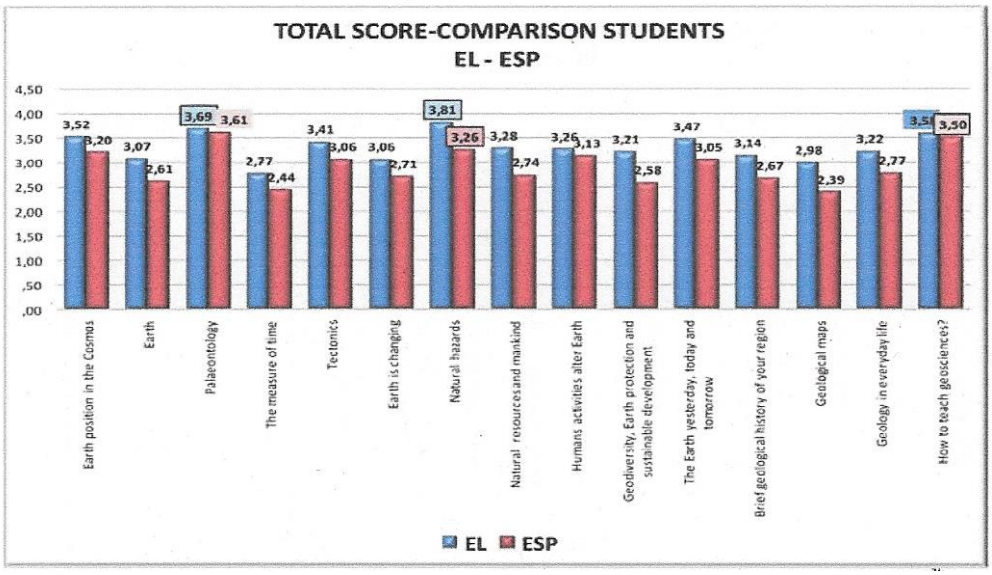

Figure 4 - Total score comparison between Greece (EL) and Spain (ESP) in the 14 topics of the research (Fermeli *et al*., 2012).

The aim of the workshop is for the participants to realise the dynamics of the natural world and recognise the perpetual changes that take place in the earth's lithosphere as far as the formation and destruction of rocks are concerned.

The objectives that are set are cognitive, affective and psychomotor (Bloom and Krathwohl, 1986, 1991). After the completion of the workshop, the participants should feel they have familiarized themselves with scientific procedures and sharpened their observation skills. They should also be able to describe the distinct characteristics which set apart the 3 types of rocks and compare them. They should feel they have clarified knowledge regarding the formation, movement and destruction of rocks and should be able to present the new knowledge acquired during the course of the workshop to the other participants, use this information on order to complete concept charts and make choices based on what they have learned. They ought to discover and display possible routes, rocks may follow inside the earth's lithosphere. During the whole process they should cooperate in their groups, organize and exchange information and also develop a positive attitude towards team work. They need to express themselves in a creative way - drawing, writing poetry or stories and share it with the rest of the group. Last but not least, an objective is for the participants to be willing to get engaged in scientific procedures and to have fun while doing so.

In the introductory stage where participants get to know each other, they are asked to present themselves declaring their names and something they fell they are good at. This activity is used with the aim of establishing a positive atmosphere at the beginning of the workshop. They are then asked to choose items of different colour and they are grouped according to colour. In the first stage five groups are formed. Each participant is given a dossier containing information and instructions about what they are expected to do. There are group activities and individual activities. The first three groups deal with the three different types of rocks, based on their most distinct characteristics, without revealing the name of the rock type initially. They are also given actual rocks representing sedimentary, igneous and metamorphic rocks to touch, observe and describe. As a final step they need to draw a picture or make a collage of something that impressed them from what they have learned. The fourth group deals with the destruction and formation of the rocks. Using a water pot, a hammer and a hair-dryer on an actual piece of rock they simulate the destructive effect of the wind and rain on the rocks. Then, they «create» sedimentary rocks using rounded sweets as pebbles, sugar as sand and flour as powder. To show how the pressure and heat affect the rocks, they put the imaginary rock in a toaster for different time periods. The whole time they observe and record the changes that take place. The longer the rock is left in the toaster, the harder it is to distinguish its initial materials. One activity also requires that the participants throw the melted rock into cold water to simulate the rapid cooling of magma as is the case of a volcano eruption. The final activity simulates the formation of crystals during the slow cooling of the magma. They dissolve sugar into boiling water and leave it to cool down. Sugar crystals are formed after a while. The fifth group deals with the different routes which can be followed by a rock in the earth's lithosphere. The pre - existing ideas of students on the topic are written down, checked and clarified. Using a metallic board illustrating part of the lithosphere, they move little magnets up and down simulating the movements of rocks. They discuss and then they write down the different routes they have discovered.

In order to move on to the second stage, participants are asked to choose a piece of four different puzzles. It is necessary that the new mixed groups should contain at least one member coming from the five previous groups. After they have found and completed the puzzles, four new mixed groups are formed. Each group is given a big concept map illustrating the rock cycle, to fill in the missing words or pictures, regarding the information they have acquired during the former stage. Each member of the group presents the knowledge previously gained and helps with the completion of the concept maps. This stage of synthesis is essential so that every participant can get acquainted with what was taught to all groups. As a final step, groups will have to present a drawing or a collage they have created, a poem or a story they have composed using all the newly - gained knowledge. The last thing they are asked to do is evaluate the whole process anonymously.

5. Results

The teachers having participated in the workshop were asked to evaluate the whole endeavour in terms of how practical the knowledge imparted was, the possibility of implementation of the methods used on other subjects as well, the fun during the procedure and the students' skills that can be improved. The evaluation sheet consisted of ten questions – mostly ranking preference, as well as an open ended question to express any thoughts they chose to share. The evaluation that we received suggested that the students' skills which would be promoted in the course of the workshop were creativity, observation, cooperation and team work, analysis and synthesis and critical thinking. They all appreciated the way it was presented and admitted to having fun while learning something interesting. Most of them also supported that the methodology used to design and present this workshop can be applied on different school subjects, which was actually one of our intentions (fig. 5). They all agreed that they would like to present this workshop to their students at school. What most of them complained about was the time available for the completion of the whole process. They felt they needed more time to process the information, to synthesize it and to present it as a group.

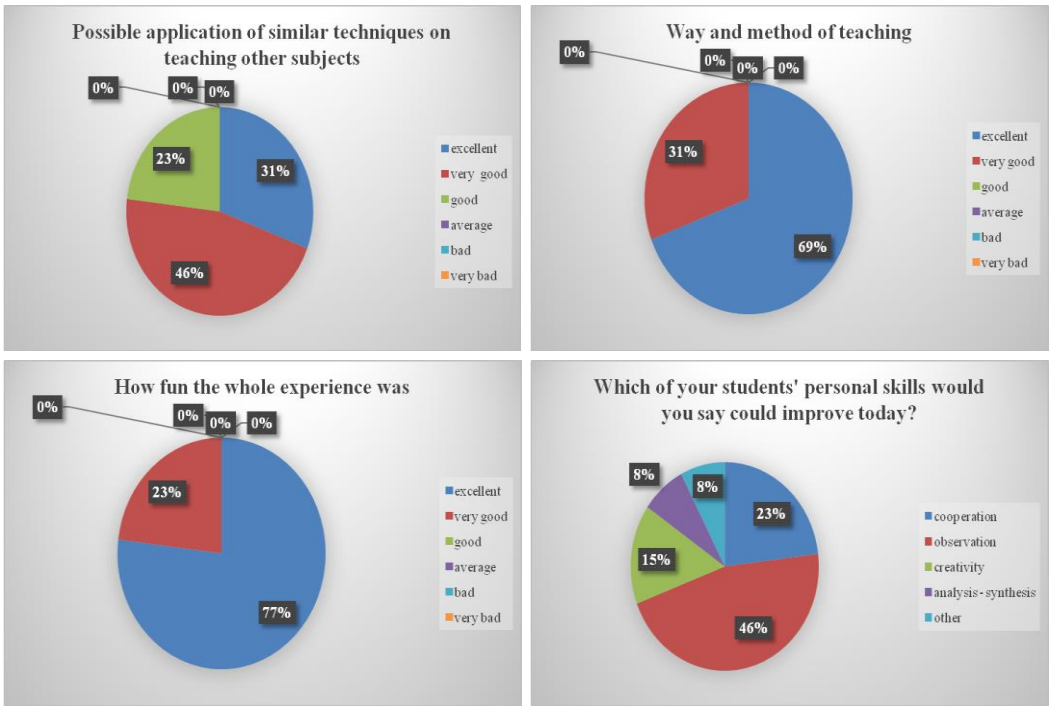

Figure 5 - Pie charts presenting the teachers' evaluations.

The students on the other hand, were asked to evaluate the way the workshop was taught, the consolidation of knowledge, the skills they think have improved through the activities and the fun they had while working together. The evaluation sheet they received consisted of 8 questions ranking preference and an open ended question to state in a sentence what they mostly liked from the process they experienced. What the children enjoyed most were the experiments and simulations conducted in the first stages of the workshop, the chance to work together in groups and also the cooperation with their teachers. They found the subject of the rock cycle really interesting and were happy with the new knowledge and they expressed their wish to be taught other school subjects in similar ways. They supported that they have conquered the new knowledge and that they would be able to explain what they have learned to someone who has little knowledge on this particular subject. They were

impressed by the way it was taught and admitted to having fun. As for the self - skills they think were improved they chose creativity, observation, cooperation and team work (fig. 6).

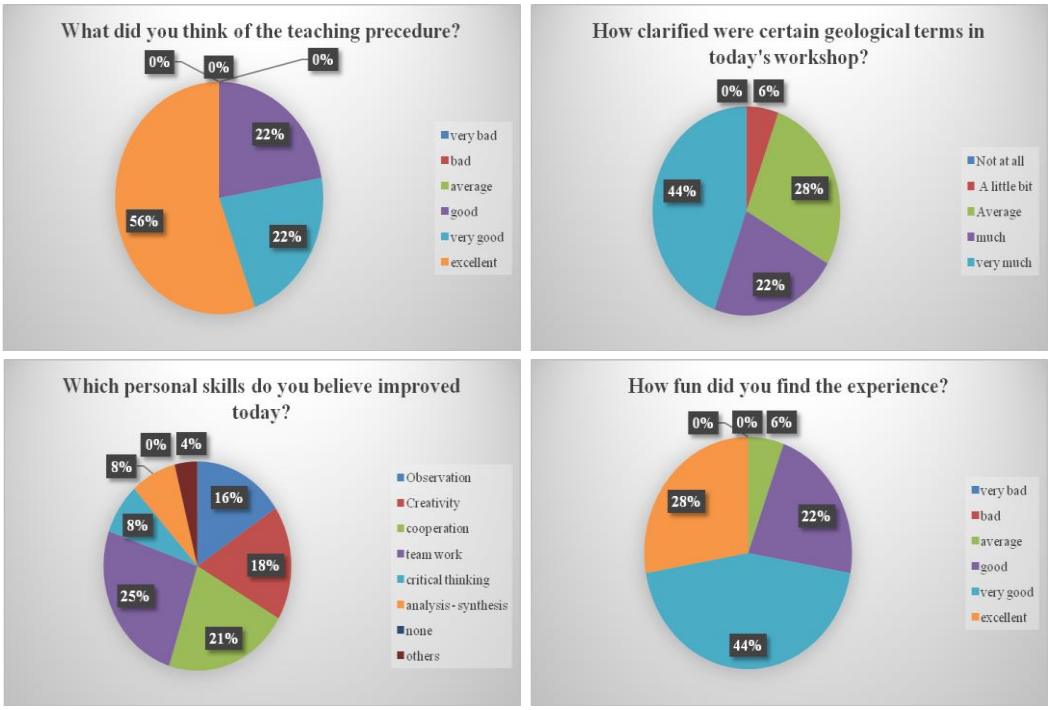

Figure 6 - Pie charts presenting the students' evaluations.

6. Discussion

It is a well-documented fact that there is a decline in students' interest towards science and a negative trend in their attitude to the science curriculum (Sjøberg and Schreiner, 2006). Experiential teaching might be the answer to this problem, with students gaining knowledge through immediate or concrete experiences, observations and reflections. ELT proposes a constructivist theory of learning (Kolb and Kolb, 2005). This is exactly the theoretical background of the workshop «Rocks: we are born, we live, we change but do we die? The cycle of our lives» or « Cooking with rocks ». As research has shown, the teaching strategies, among other topics, are what most students and teachers are interested in when it comes to teaching Geosciences. The innovative methods used to design this workshop, the experiments and simulations which are included in it, received a lot of positive comments from the participants. Not only were they able to improve their creativity skills, but they also had a lot of fun working as teams. The otherwise difficult geological terms regarding the formation and destruction of rocks along the course of their cycle, were clarified to such extend that participant were rendered capable of imparting this particular information to others. Students really appreciated the spirit of cooperation with their teachers and teachers found the whole process highly beneficial for their students, as they supported that a lot of different skills would be improved. The holistic approach of teaching should be taken into account when it comes to teaching Geosciences. The focus should not be exclusively on the knowledge itself but on the procedure followed during the course of the lesson and the interaction among the students and their teachers. The only drawback that was recorded during the whole process is the time it takes. One should bear in mind that such teaching approaches need a lot of time to be presented and completed, more than conventional teaching methods, not to mention the time spent for their planning and design. They are good teaching practices that produce better results and such endeavours should be encouraged in schools.

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