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Message from the Editor-in-Chief

We are really happy to announce that we have published TOJRAS issue. In this issue we have 19 articles from different authors and different countries. I would like to thank all TOJRAS authors for their great effort and supporting our journal. In this respect, I would like to thank to editorial board, reviewers and the researchers for their valuable contributions to the journal current issue.

Prof. Dr. Aytekin İŞMAN

Editor-in-Chief of TOJSAT

Message from the Editor

Dear Tojsat Readers,

This is the second issue of the Journal of Science and Technology which covers the whole areas of Science and Technology all over the World. Studies either applied or social sciences that are used to fill in the gap between science and technology. Globally, this century scientific and technological developments are going very fast and importance of the journal will be most important for the papers.

The journal, which covers all scientific and technological subjects, is published 4 times a year. Selected papers of the Science and Technology Conference will be published in the journal. The selected topics of this issue of the journal cover from Intelligent Data Mining For Automatic Face Recognition to Investigation of Changes of Pre-service Teachers' Opinions about Environmental Education with Drawing Analysis.

Prof. Dr. M. Şahin DÜNDAR

Editor, TOJSAT

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A Fast Method For Accessing Nodes In The Binary Search Trees

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Abstract: In this study, a method that makes easy to process in the search trees is presented. A data structure which uses this method is also explained. It is explained how this method is used for strings. Performance comparisons with other trees like AVL, RB tree are showed. A hash table and a balanced binary search tree are used to implement this data structure. It is built the categorized subtrees according to data. Hash table is used to access data in the subtrees. It is aimed to process on relatively less amount of data collections instead of large amount of data collections. In this way the numbers of the process will be decreased. It will make positive affect on the program performance.

Keywords: Balanced binary search tree, Hash table, AVL, RB Tree, Salkim Tree

Introduction

The study of data structures is core to computer science. A wide range of container structures have been developed to meet different problem situations. The focus on data structures that efficiently store large collections of data (Tremblay J. P., 2003; Ford W. and Top W. 2002).

Data structure determines performance of the software. When program use large collections of data then data structure selection is getting more important. The structures have operations to access items, insert items and remove items from the collection. Effectiveness of a program depends on performance of deletion, insertion and searching process (Robson R, 1999; Weiss M. A., 1994).

Data can be stored in a memory sequentially or associatively. Data structures which are stored sequentially save data with position in a memory. When a data with value is wanted to be found, O (n) times search will be needed. Data structures, which save data with value in memory, are more suitable in this situation. This type of data structures is called associative data structures. These data structures are updated by using values, instead of using positions in associated data structures. Tree, is an example of this kind of data type (Larsen Kim S., 2000). AVL (Adelson Velskii and Landis) and Red-Black trees are the most important examples of tree data structure.

AVL Trees

AVL trees are binary search trees which are locally balanced. Depth of the AVL trees is arranged as O (logn). This means that AVL trees have the same depth of the left and right sub trees. The difference between left and right sub trees of any node can be one or zero. Cost of AVL algorithms is O (logN), when these algorithms are used for building tree, deletion, insertion and searching process (Larsen Kim S., 2000, Gabarró J. and Messeguer X., 1998; Cameron H. and Wood D., 1994).

AVL (Adel'son-Vel'skii and Landis) trees are efficient data structures for implementing dictionaries. AVL trees are binary search trees which are locally balanced; that is, for any internal node, the heights of its left and right subtrees may differ by at most one. The local balance at each node guarantees that the height of an n-key search tree will always be bounded above by $1.44 \log(n+2)$. Since AVL trees are the most efficient method of balancing binary search trees, they are utilized in a wide variety of applications such as databases, operating systems, and symbol tables in compilers.

T, an AVL tree, is a binary tree in which the difference between the heights of the left and right subtrees of any node is at most one. Elements from a totally-ordered domain are stored in the leaves with smaller data to the left of larger ones. For each internal node *v*, we use *k (v)* to refer to the key value stored in it and *l(v)* and *r(v)* to denote the left and right children, respectively. Moreover, *k (v)* always equals the key value of the largest element stored in node *v*'s left subtree. Such trees are usually referred to the literature as external AVL trees.

When we insert a new node into an AVL tree, some external nodes are replaced by a new internal node (and two external nodes as its children), and the height of the parent of new node may have been increased by one. As a result, if the height of newly inserted node is increased, the property of AVL tree may be lost at the ancestors of this new node. When the insertion causes an AVL tree to loose its balance, applying exactly one of the four rotations—*single rotations LL or RR* and *double rotations LR or RL*—will restore it.

Red-Black Trees

The red–black tree is a balanced binary search tree whose height is O(log n) and dictionary operations such as search, insertion, and deletion are performed in O(log n) time in sequential computation, where n is the number of nodes in the red–black tree.

In Red-Black tree (RB tree), every node has RED or BLACK attributes. Tree operations, except insertion, are costed O (log n) in RB tree. Insertion of an element will violate balance of tree which must be rebalanced. Rebalance process can be achieved with a simple operation, called rotation (Park H. and Park K., 2001; Cameron H. and Wood D., 1994).

Let root(T) denote the root node of a red–black tree T and item(x) denote the item stored in node x. Let p(x) denote the parent of node x and $p^{n+1}(x)$ the parent of $p^n(x)$, $n \geq 1$. Let rchild(x) denote the right child of node x and lchild(x) the left child of x. The successor of node x is the node with the smallest item larger than item(x). The predecessor of node x is the node with the largest item smaller than item(x). Each node x has a space for its item, a bit for its color (red or black), and three pointers to p(x), lchild(x), and rchild(x). If a node does not have a parent or a child, nil is stored in the corresponding pointer. We will regard nil as a pointer to an external node (leaf) and the nodes holding items as internal nodes.

A red–black tree is a binary search tree satisfying the following red–black properties (Park H. and Park K., 2001).

1. Every node is either red or black.
2. Every external node (nil) is black.
3. If a node is red, then both its children are black.
4. Every simple path from a node to a descendant leaf contains the same number of black nodes.

The red–black properties can be rewritten using nonnegative ranks instead of red and black colors

(a) If x is any node with a parent, $rank(x) \leq rank(p(x)) \leq rank(x) + 1$.
(b) If x is any node with a grandparent, $rank(x) < rank(p^2(x))$.
(c) If x is an external node, rank(x) =0 and rank (p(x)) =1 if x has a parent.

The above conditions (a)–(c) are called balance conditions. The rank of node x corresponds to the number of black nodes in any simple path from x to a descendant leaf. Hence, rank (p(x)) =rank(x) + 1 if x is black and rank (p(x)) =rank(x) otherwise. Note that rank(x) need not be stored in x. (Park H. and Park K., 2001; Cameron H. and Wood D., 1994).

Salkim Tree

A data structure is a systematic way of organizing and accessing data. It is focused on data structures that store large collections of data. It is needed new data structures that can efficiently add and remove items without involving the entire collection of elements. In this study, Salkim tree is proposed to address this problem.

A hash table and RB binary search tree are used together to build Salkim tree. Collision case of hash table is used to categorize data. Selected hash function generates same index for different data in same category. Data are stored in a special form of binary search tree. In this form, root has one element which provides connection between tree and hash table. Data are stored in meaningful subtrees instead of one tree. When a process is needed for an element, process will work in related subtrees instead of all trees.

Implementation

When this data structure is wanted to build for letters, records are generated for each letter in hash table (Hrádek J., 2003; Zobel J., 2001). For this aim, hash function is used to generate index. Index value shows location of each letter in hash table. The root addresses of each subtree are stored in hash table. Hash function is shown in equation 1.

$$H(x)=ascii(x)-65 \quad (1)$$

Address records of subtrees are generated statically in hash table. Initial value of address records are NULL.When a string is wanted to be added to the structure, firstly hash table is checked whether subtree is created or not. If related subtree is created then string will be added to this subtree, otherwise a root will be created and string will be added to this root. The address of the created root will be written to the related place in the hash table.

Searching process of an element; hash table is checked whether related subtree exists or not. If subtree does not exist, no need more completion, it can be said that element does not exist in structure. Otherwise searching process will continue in related subtrees.

For example, lets assume that ‘train’ word is wanted to search in structure, Firstly index value of ‘t’ is calculated using hash function (index value of ‘t’ is equal to 19). 19 th section of hash table is checked whether any address exists or not. If 19 th section value of hash table is NULL, then it can be said that ‘train’ does not exist in the structure, otherwise ‘train’ word will be searched in ‘t’ subtree. If ‘train’ word is wanted to search in any tree, all trees must be searched though it does not exist. This situation increases the cost of searching process in an ordinary binary search tree.

For example, cost of searching an element, in a balanced tree with 26000 elements, is 15. Salkim trees’s cost is 10 in the same situation (when all letter categories have 1000 element).

Assuming that number of element is N and number of element started with ‘i’ is Ni,

$$N=Na+Nb+ \dots +Ni+ \dots Nz \quad (2)$$

Assuming that all element is not started with ‘i’, it can be said that

$$Log_2N>log_2Ni \quad (3)$$

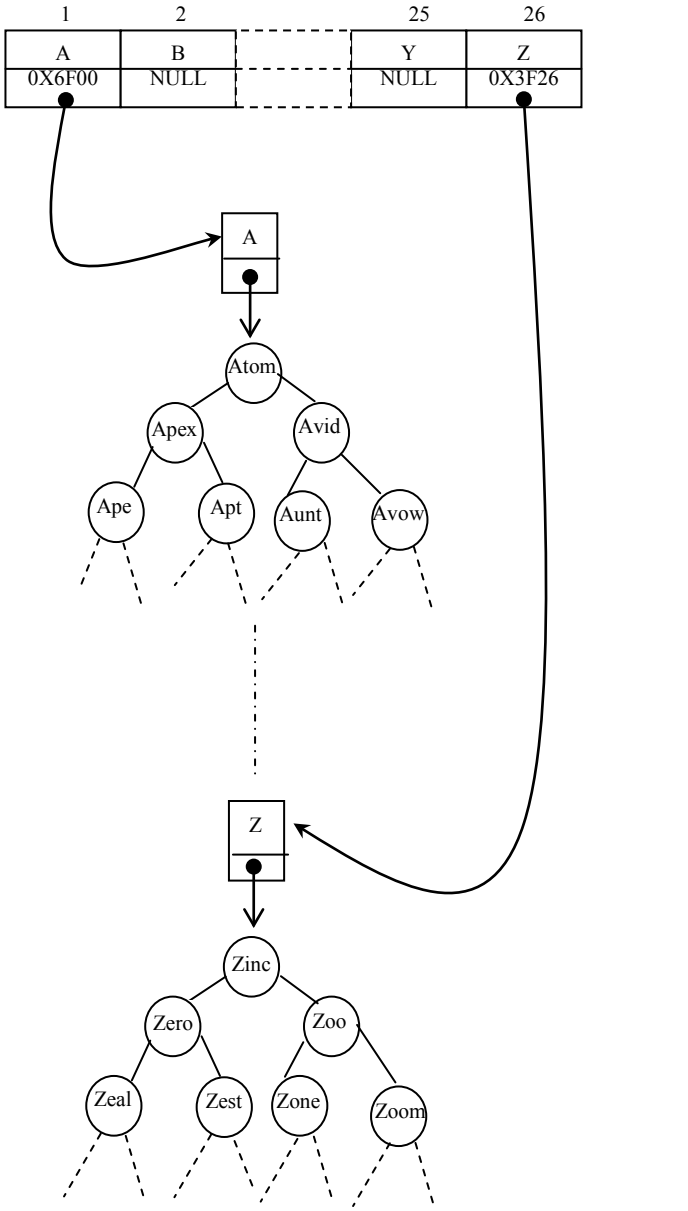

Figure 1. To access subtrees using hash table

Results

An application program is written to analyse building structure, inserting an item and searching an item performances of AVL, RB tree and Salkim.

Performances of building structure are examined for five different data sets. Amount of data in data sets are 25000, 275000,350000, 550000, 1100000. X axis of figures demonstrates these data sets. Y axis demonstrates process time. Build performance of those data structures is shown in Figure 2.

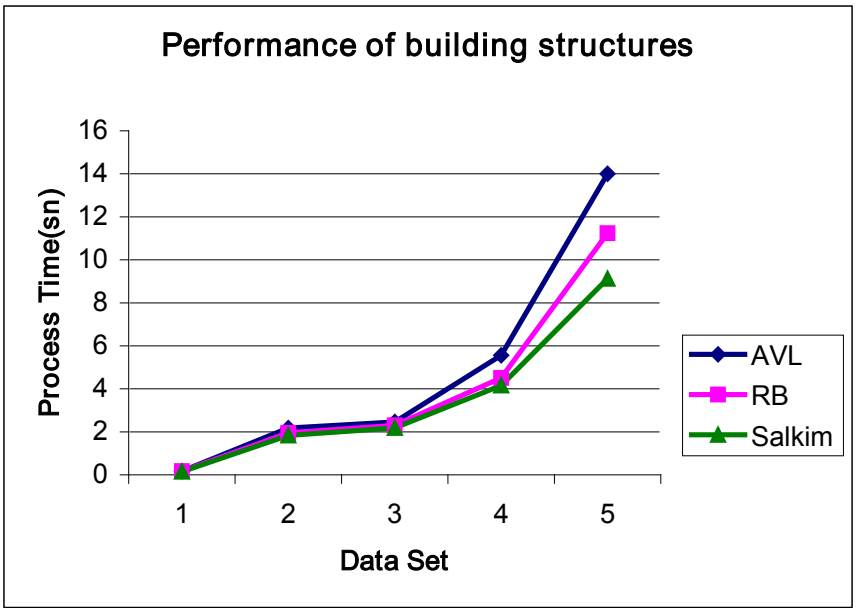

Figure 2. Performances of building structures

Table 1. Performance values of building structure test.

Data Set	Number of Data	AVL	RB	Salkim
1	25.000	0,17	0,17	0,15
2	275.000	2,173	1,956	1,833
3	350.000	2,46	2,303	2,18
4	550.000	5,56	4,506	4,156
5	1.100.000	14,006	11,237	9,124

Insertion performance of AVL, RB and Salkim tree is shown in Figure 3 and Table2. Note that all data structure was including 25000 elements before insertion test. Insertion performance is tested for four cases, in first case 100000, in second case 1000000, in third case 5000000, and in fourth case 10000000 elements are added into each structure.

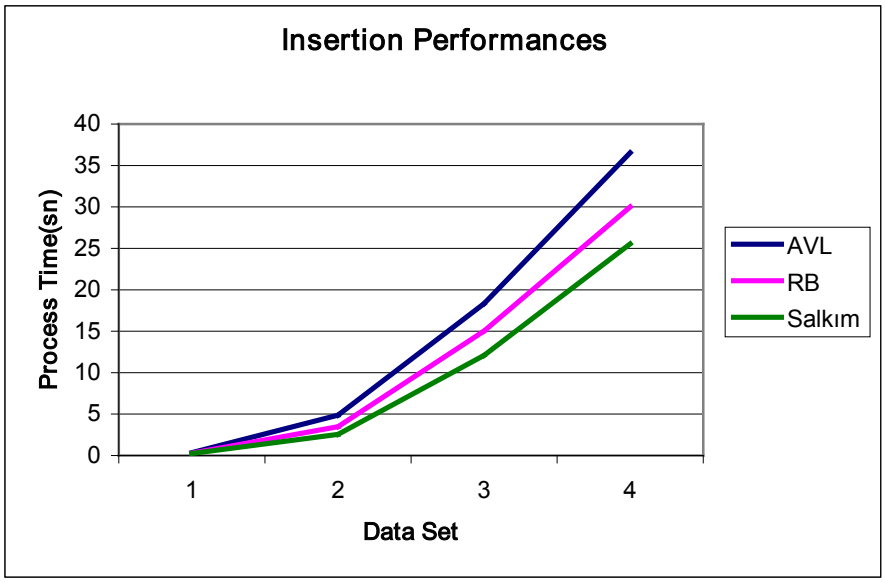

Figure 3. Performances of insertion item

Table 2. Performance values of insertion item test

Data Set	Number of inserted data	AVL	RB	Salkim
1	100.000	0,341	0,29	0,25
2	1.000.000	4,87	3,475	2,56
3	5.000.000	18,326	15,02	12,083
4	10.000.000	36,532	30,014	25,543

Search performance of structures is shown in Figure 4 and Table3. Note that all data structure was including 25000 elements before search test. Search performance of structures is tested for four cases. In first case 100000, in second case 1000000, in third case 5000000, and in fourth case 10000000 elements are searched on each structure.

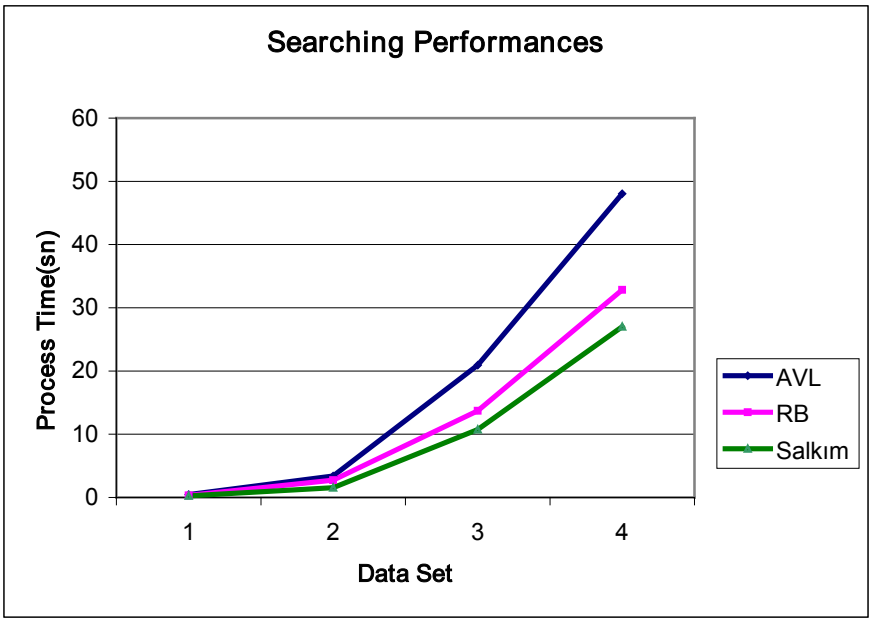

Figure 4. Performances of searching item

Table 3. Performance values of searching item test

Data Set	Number of searched data	AVL	RB	Salkim
1	100.000	0,451	0,341	0,25
2	1.000.000	3,395	2,744	1,542
3	5.000.000	20,92	13,71	10,752
4	10.000.000	48,037	32,837	27,01

Conclusion

Performance of Salkim tree is better than AVL and RB tree which are preferred in a lot of applications. Especially, search performance and insertion performance of Salkim tree's superiority is getting clearer when number of data increase.

Acknowledgement

We would like to thank people who are worked in Akcasu Software Corporation and Oea International Inc. Implementing of this study would be harder without their help.

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An Investigation of the Effect of Project-Based Learning Approach on Children's Achievement and Attitude in Science

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Abstract: The aim of this study is to examine the effect of project-based learning activities on the fifth grade children's science achievement and their attitudes towards science course for the unit on 'Sound', and to compare the effectiveness of project-based learning over more traditional teaching methods. The study was carried out with 44 fifth grade students at a public primary school in the Northwestern part of Turkey, during the spring term of the 2011-2012 academic year. Students were randomly divided into two groups as control group (CG, n=22) and experimental group (EG, n=22). Initially, pre-tests (an achievement test and an attitude scale) were applied to both the CG and EG. Following the four weeks, the EG was taught using the project-based practices, while the CG was taught using more traditional teaching practices. Children in the EG carried out three science projects for the science unit on 'sound': *Bite and hear*, *making music with glass bottles,* and *designing a house with sound insulation.* Then, the post-tests were carried out in order to determine the effect of a project-based learning approach on children's learning. The research findings revealed that children's science achievement significantly improved with the project-based activities, but their attitudes toward science did not change.

Key words: Project-based science, science teaching, sound unit.

Introduction

Over the last three decades, project-based learning has been widely supported in science education (Egenrieder, 2007), and today it is an important component of science education. Many current curricula emphasize project-based teaching as a favored method for "motivating students and facilitating greater retention of learning" (Barak & Raz, 2000, p.28). In this context, the American Association Advancement of Science [AAAS] (1993), the National Research Council [NRC] (1996) and the Turkish Ministry of National Education [MNE] (2005) emphasized inquiry based instructional methods to improve student learning in science and to enhance the success of educational reforms movements. Many research revealed that the integration of inquiry based approaches via project-based studies in science courses improves students' deeper understanding of science (Alozie, Moje, & Krajcik, 2010).

Project-based science teaching is grounded in constructivist theory and provides many opportunities for transforming classrooms into active learning environments (Krajcik, Blumenfeld, Marx, & Soloway, 1994). According to constructivist approach, learner constructs knowledge personally, through relating new knowledge to prior experience, or socially, through interaction with people around, such as friends, teachers, family, etc. (Bates, 2005). Project-based learning supports the constructivist principles; working collaboratively with others, reflecting on what have been learned, personal autonomy and active engagement. Therefore, project-based learning is viewed as a type of inquiry learning (Egenrieder, 2007). Rather than rote procedures, it encourages students to construct their own knowledge and understanding.

Project-based teaching is based on challenging and driving questions that involve students in problem-solving and decision making process (Thomas, 2000). Through project-based teaching, students find solutions to real world problems by asking open-ended questions, designing and conducting investigations, researching problem, gathering information, drawing conclusions based on the findings, and reporting results (Schneider, Krajcik, Marx, & Soloway, 2002). Ladewski, Krajcik and Harvey (1994) pointed out that projects require an authentic real-word problem that drive activities and result in a series of products related to the problem. Projects represent students' emerging understandings and allow students to engage in investigations. According to Solomon (2003), by examining work of others, students learn to improve the quality of their work and to communicate more clearly and

effectively. Furthermore, many researcher (Kucharski, Rust, & Ring, 2005; Papastergiou, 2005) emphasized that project-based learning plays a crucial role in increasing motivation of students. Project-based learning increase student motivation, improve achievement, and provide positive learning experiences and authentic problem-solving opportunities (Gulbahar & Tinmaz, 2006).

One of the crucial factors in learning science is children's attitude (George, 2006). A positive attitude toward science is commonly considered as a predictor of behavior, and thus they influence science achievement and interest in science (Carey & Shavelson, 1988; Koballa, 1992). On the other hand, negative attitudes may lead to lack of interest for science learning (Weinburgh, 1998). Koballa and Crawley (1985) emphasized that attitude toward science "fulfills basic psychological needs, such as the need to know and the need to succeed." Therefore, attitudes toward science are considered "to influence future behaviors, such as interest in working on a science project" (p.224). A high number of studies has investigated the importance of attitudes in learning science and the relationship between attitude and science achievement (Oliver & Simpson, 1988; Papanastasiou & Zembylas, 2004). In this context, a comprehensive work carried out by Weinburgh (1995), based on meta analysis of 43 studies, showed that a positive attitude towards science appears to be a predictor of higher achievement.

When the science education literature is reviewed, it is seen that growing amounts of research explored the effect of project-based science teaching on science achievement and attitudes towards science course abroad and in Turkey. For example, Doppelt (2003), aiming to advance low-achieving students, defined significant goals for the pupils and the teachers, and then carried out original projects taking advantage of the pupils' special skills and abilities. He reported that project-based learning elevated pupils' motivation and self-image at all levels and achieved significant affective learning. Most of the low-achieving pupils succeeded with distinction in the same matriculation exams that the high-achievers did in the same school. The study conducted by Rivet and Krajcik (2004), with 24 teachers and over 2500 students by designing project-based curriculum materials that contextualize the learning of science in meaningful real-world problems, revealed that project-based curriculum materials promoted learning of important and meaningful science content aligned with standards. In another research, Papastergiou (2005) investigated a project-based learning environment and its impact on student teachers. The participants were 46 student teachers. The research indicated that the project-based learning approach has been motivational and effective regarding the acquisition of design and development skills. The participants became more interested in and self-confident about project subject. In a similar study, Kanter and Konstantopoulos (2010), aiming to determine the effect of a project-based science curriculum on students' science achievement and attitudes, provided professional development to bolster urban teachers' science content knowledge and science pedagogical content knowledge. They found that students' science achievement improved with the project-based science curriculum, but that their attitudes toward science and plans to pursue science did not.

In Turkish literature, Korkmaz and Kaptan (2002) examined the effect of project- based learning approach on the academic achievement and academic self-concept and study time of 7th grade students. While the control group followed textbook and teacher-centered activities, the experimental group students experienced a project-based learning. After the project process, they reported that there was a significant difference in favour of experimental group in terms of academic achievement, academic self-concept and study time. In a similar study, Altun Yalçın, Turgut and Büyükkasap (2009) aimed to determine the effect of project based learning on the first year science undergraduates' attitudes towards physics, electricity achievement, and development of scientific process skills. They used quasi-experimental nonequivalent groups pretest-posttest design study, and the sample consisted of total of 90 first year science undergraduates enrolled in the Science Teacher Training Department in Bayburt Education Faculty in 2006–2007 academic year in Turkey. Their research findings revealed that there were statistically significant differences between experimental and control group with regard to students' attitude toward physics, electricity achievement and scientific process skills. The experimental results also support the idea that the project based learning improved the students' learning and helped their attitudes towards physics and research skills to enhance. Sert Çıbık (2009) investigated the effect of project based learning approach to the development of attitude of seventh grade students towards science. A total of 44 students (22 in the experimental group and 22 in the control group) participated in the study. At the end of the study, when the experimental and control group results are compared, there was a meaningful difference in favor of experimental group.

Similar to the present study, Deniş Çeliker and Balım (2012) investigated the impact of project-based learning of the "Solar System and Beyond: Space Puzzle" unit on the seventh grade students' achievement. They used quasi-experimental pre-test - post-test control group design. At the end of the study, they reported that academic achievement of students in the experimental and control groups regarding the unit was found to be significantly

different in favor of the experimental group. Karaçallı and Korur (2012) carried out a study to explore the effect of project based learning approach on the 4th grade students' academic achievement, their attitude and persistency for the unit electricity. While the unit electricity is taught with project based learning approach in experimental group (73 students), the control group followed the traditional method (70 students). The results showed that project based learning increased students' achievement and retention of knowledge. However, there was no statistically significant difference among groups in terms of their attitudes toward science. In another study, Şahin and Benzer (2012) investigated the effect of project development strategy of the four questions on the scientific process skills of science teachers and elementary students. The study group consisted of 14 teachers studying in the graduate programme and 111 middle elementary school students. Through the use of quantitative and qualitative research techniques, they found that project implementation with the four questions strategy has a positive effect on the scientific process skills of each working group. However, as different from many studies in the literature, Ayan (2012), in her research about the effect of project-based learning approach on the academic achievement of fifth grade students, did not report any significant differences between control and experimental groups.

In sum, many research in the literature examined the impacts of project-based teaching and more traditional learning activities on student achievement and attitudes. These studies commonly emphasized the project-based science teaching as a useful pedagogical strategy enabling students to improve meaningful learning and to make connections between their real-life experiences and new information. As Tamir (1998) stated, teaching style affects both students' achievement and attitudes toward science. In this context, this study explored the effect of project-based learning activities on the fifth grade children's science achievement and attitude towards science for the science unit on 'Sound'.

Materials and Method

Research design

In this study, the pre-test post-test control group of quasi-experimental research design was used (Cohen & Manion, 2000).

Participants

This study was carried out to improve the learning experience for the children through the project-based learning strategies during the spring term of the 2011-2012 academic year. Participants consisted of 44 fifth grade students at a public primary school in the Uzunköprü-Edirne district located in the Northwestern part of Turkey. Students were divided into two groups, a control group (CG, n=22) and experimental group (EG, n=22). The control and experimental groups were regular classrooms.

Instruments

In this study, data were collected through the use of two instruments; an attitude scale and an achievement test. Children's science achievement was measured by *the Light and Sound Achievement Test* developed by Salgut (2007). Reliability coefficients of this test were determined by the KR-20 method. The KR-20 coefficient of the test was .92 (Salgut, 2007). Children's attitude was measured by *the Scale for Attitudes towards Science Course* which was developed by Altınok (2006). The Cronbach alpha reliability coefficient of the attitude scale was .92 (Altınok, 2006). Students' responses on the Attitudes toward Science Course scale ranged from strongly agree (5) to strongly disagree (1).

While the class teacher taught in the CG, the courses in the EG were conducted by the researcher. The researcher was also a class teacher and had ten years of teaching experience. It is worth noting that the researcher had participated in science project competitions before, and thus had the experience of the project-based learning approach, and knew how to properly conduct children's project works. During the application of project works, the researcher carefully observed the all students, and guided them sometimes by giving clues, sometimes by encouraging them to find solution by themselves.

The Application of Teaching Activities

This study continued five weeks. The first week, initially children were given a brief information about the aim of the study and process of conducting a science project. Then, pre-tests consisting of attitude scale and achievement test were applied to both the CG and EG. During the following four weeks, the EG was taught using the project-based activities in science lessons (a total of four hours per week). As for the CG, science courses were carried out through the routine course plans in accordance with Science and Technology course instruction program. The CG followed the activities in the fifth grade Science and Technology textbook. The children in the experimental group completed project planning and preparation form and project evaluation form for each project work. Three science projects conducted with children are briefly explained below.

Making Music with Glass Bottles. The first project work children undertake for the unit sound was "*Making Music with Glass Bottles"*. The previous week the researcher had instructed pupils to search about 'what is sound', 'how sound is produced' and 'how sound travels' using internet, textbooks or other reachable materials. The researcher had also requested children to bring identical glass bottles to science course. At the beginning of the science course, the children in groups filled in the project forms, which explain aim of the project and roles of project team members. Later, the researcher let children enjoy with glass bottles for a while. During this process, she instructed children to hit the different parts of bottles e.g. while holding a bottle in hand and while a bottle standing on table, and directed some questions to them as well. For example, "What happens when you hit the bottle standing on the table or while you are holding bottle in your hand?" "Do you hear a different sound?" "Is there a difference between sounds?".

Using bottles to make music is an interesting science project for children, and thereby, explores how volume and liquid affect sound waves. In this project, children use only seven-eight empty bottles and some water. The bottles must be all the same, such as empty glass soda or fruit juice bottles. At the beginning, children stand eight empty bottles side by side on a table, and then fill the bottles with different amounts of water. Fill the bottle on the left with some water, and add water to the next bottle so that the water level is a bit higher than in the first bottle. Each bottle must have a little bit more water in it than the bottle to its left. There is one variable, which is the amount of water. Initially, using a metal spoon, children tap the each bottle with a metal spoon and compare the pitch of the sounds produced. Tapping the bottle causes the bottle and its contents to vibrate. The pitch of the sound is determined by how fast the bottle and its contents vibrate. As the water inside the bottle decreases the vibrations increase, and this causes to a higher pitched sound. Sound is a form of wave energy that moves outward from the vibrating bottles.

Later, children blow across the each bottle and compare the pitch of the sounds produced. When they blow across the bottles from left to right, the bottles with more air produce low sounds, and the bottles with less air produce high sounds. Blowing bottles cause the air inside to vibrate and the amount of air in the bottle affects the sound it makes. The bottle with the most water has the least amount of air, thus it produces a sound with the highest pitch, due to faster vibration of air molecules. In sum, blowing across the tops of the bottle instead of tapping them change the sound produced. During this project work, by adjusting the amount of water in each bottle, children produced a whole musical scale.

Making Headphone / How Headphone Works. In this project work, children learn how headphones carry the sound from the music player to the headphones. Headphones and speakers have a similar design. Children have initially taken apart a headphone and observed the components in the classroom. Taking a headphone apart is an effective way to find out how they work. Then, they started to construct a model of headphones to be able to better understand how headphones function. Materials needed to make a headphone are a coil of copper wire, a magnet, an audio cable and a dry branch. A headphone contains a magnet and metal coil just above of the magnet. First, by winding the copper wire around the dry branch, we composed a kind of coil on the branch. Then, we attached a strong magnet on the coil by using a tape. The coil is just below the magnet and the each end of the copper coil was connected to two tiny copper wires from the audio cable that connects the headphone to the music player.

When electricity (audio wave) passes through the wire or travels from the music player to the coil, a small magnetic field is produced around the metal coil, and the coil becomes electromagnet. The magnetic coil, then, interacts with the original magnet, causing them to rotate between repelling and attracting each other. In the headphones, the coil is attached to a diaphragm and this rotation causes to the vibration of diaphragm. This movement vibrates the surrounding air, and produces sound waves out from the headphones, or in our case, straight

into our ears. In essence, the electrical signal representing an audio wave in the coil is turned into sound waves. When we bite dry branch, the vibrations reaches to our eardrum, and our ears interpret these vibrations, and thereby, listen to the music playing. Children really appeared to be very enthusiastic about this project work. They worked willingly during the project activity and asked many questions concerning how sound travels from one material to another.

Developing Sound Insulation in Our House. In this project activity, children tried to answer the question how to reduce or minimize sound traveling in a house. Initially, children in groups talked about what is noise, the noise pollution in the environment, and how the noise affects our life negatively. Later, they discussed about how to develop sound insulation in a house. Then, they put quartz clock in a box and, using everyday materials such as carpeting, cotton, fabric, cloth etc., tried to insulate tic tac sound of quartz clock that should not come out.

Sound travels as waves through the air. Sound is either absorbed or reflected by a surface. Sound insulation is the resistance to sound. Sound insulation materials act as a sound absorber. The best materials are those that absorb the sound waves effectively: carpeting, cotton, fabrics, cloths, cork board, rock wool and fibreboard, etc. Following the week, the post-tests were administrated to both the EG and CG in order to reveal the effect of project based activities on children's achievement and attitude.

Findings

The independent samples t-test compares the mean scores of two groups on a given variable. At the beginning of the study, independent samples t-test was used to determine whether two groups were equal in terms of their attitudes towards science course and achievement on the 'sound' topic. The pre-test results are presented in Table 1 and 2 below.

Table 1. Pre-test results of the independent samples t-test for students' achievement in the sound topic.

Pre-test	Groups	n	Mean	SD	t	df	p
Achievement	Control G.	22	12,00	4,74	-,072	42	,94
	Experimental G.	22	12,09	3,60			

Table 2. Pre-test results of the independent samples t-test for students' attitudes towards science course.

Pre-test	Groups	n	Mean	SD	t	df	P
Likeness	Control G.	22	50,18	4,76	,749	42	,46
	Experimental G.	22	48,95	6,04			
Participation	Control G.	22	71,59	6,64	,801	42	,43
	Experimental G.	22	69,77	8,33			
Determination	Control G.	22	6,23	1,57	-1,257	42	,22
	Experimental G.	22	6,86	1,78			

As seen in Table 1 and 2, there was not a significant difference between the two groups' pre-test scores [$t(42)_{(achievement)}$=.-072, p>.05; $t(42)_{(likeness)}$=.749, p>.05; $t(42)_{(participation)}$=.801, p>.05; $t(42)_{(determination)}$= -1.257, p>.05] which indicates two groups were equal in terms of students' attitudes towards science course and achievement in the sound subject.

At the end of the project-based activities, the independent samples t-test was used to determine the differences, if any, between the experimental and control group scores. The results are given in Table 3 and 4 below.

Table 3. Post-test results of the independent samples t-test for students' achievement in the sound topic.

Post-test	Groups	n	Mean	SD	t	df	P
Achievement	Control G.	22	13,00	4,44	-8,056	33,30	,00
	Experimental G.	22	21,77	2,52			

Table 4. Post-test results of the independent samples t-test for students' attitudes towards science course.

Post-test	Groups	n	Mean	SD	t	df	P
Likeness	Control G.	22	50,00	4,48	-,070	42	,95
	Experimental G.	22	50,14	8,02			
Participation	Control G.	22	70,95	8,34	-,581	42	,56
	Experimental G.	22	72,55	9,76			
Determination	Control G.	22	6,23	1,82	-1,508	42	,14
	Experimental G.	22	7,18	2,34			

According to Table 3, there was a significant difference in terms of achievement between the control and experimental group [t(33.30)= -8.056, p<.001]. Project-based learning seemed to increase children's achievement in science as a result of making learning more enjoyable and meaningful e.g. motivating children to take responsibility for investigation, giving them opportunity to negotiate about the possible solutions to the problem, to address their ideas and to form their own models, etc. These findings support the previous studies conducted by Doppelt (2003), Kanter and Konstantopoulos (2010), Rivet and Krajcik (2004), Deniş Çeliker and Balım (2012), Sert Çıbık (2009), and Turgut and Büyükkasap (2009). However, as seen in Table 4, no significant difference was found between the post-test results of the control and experimental group for attitudes towards science course [$t(42)_{(likeness)}$=-.070, p>.05; $t(42)_{(participation)}$=-.581, p>.05; $t(42)_{(determination)}$=-1.508, p>.05]. One reason for this situation might be the difficulties children experienced during the project works. It is worth noting that although the findings of the experimental group were not significantly higher for attitudes, the mean results for the experimental group were slightly higher than the control group. Similar to the findings of the present study, Karaçallı and Korur (2012) reported that project based learning increased 4th grade students' achievement but there was no statistically significant difference among groups in terms of their attitudes toward science.

Discussion and Conclusion

This study revealed that students carrying out project-based activities had significantly higher achievement than those who continued taking routine teaching in science courses. On the other hand, there was not a significant difference between the control group and experimental group for their attitudes towards science course. This indicates that the use of project-based learning experiences for relatively short term (four weeks) do not lead to a significant increase in students' attitude towards science course. However, learning appears to be more effective with the use of project-based activities.

The outcomes of project-based learning in this study suggest that teachers need to alter their teaching styles towards more student-centered and project-based activities. According to Putnam and Borko (1997 in Tal et al. 2006), teachers should change their knowledge, beliefs, and practice in order to help students to improve their understanding, and their use of higher cognitive skills. This change includes not only learning new techniques, but also the overall perception of new teaching beliefs that direct future practice.

Project-based learning urges students to take responsibility for their own learning (Gonzales & Nelson, 2005). According to Kanter and Konstantopoulos (2010) the inquiry-based aspect of project-based teaching provides knowledge construction and allows students doing science rather than memorizing facts. In this process, teachers play a crucial role in enacting the intended curriculum and taking over the centrality of inquiry and active

construction of knowledge. Furthermore, they guide students to work on task, present the ideas, and build relationships (Tal, Krajcik, & Blumenfeld, 2006). During the project work process, teacher should play the role of a guide and facilitator giving feedback on goals pursued (Kurzel & Rath, 2007). Similarly, Solomon (2003) and Grant and Branch (2005) emphasized that teachers need to help students to set goals and to break the project into attainable steps and to serve as a facilitator, guiding and advising students. Kanter and Konstantopoulos (2010), based on their research findings, emphasize that the extent of the success of a project-based science curriculum appears to be dependent on elements of both teacher content knowledge and pedagogical content knowledge, and teachers' frequency of use of inquiry-based activities.

Many factors affect a child's motivation and interest to work together and to learn new things in class. In this study, the new project experiences or challenges which are different from classical class activities seemed to enhance children's self-motivation. The children showed different levels of interest in different project works. Making headphone activity was the most interesting project work from children' point of view. It is widely agreed by the educators that children take greater ownership in their projects when the project is attracting them, interesting for them. Therefore, science teachers who take on a broad scope for science projects can be better able to motivate students whose interests may be in the different topics. This also enables students to make connections between their classroom experiences and their interests (Egenrieder, 2007, 5).

Given that many studies have found positive relationship between attitude toward science and higher science achievement (Schibeci & Riley, 1986; Oliver & Simpson, 1988; Schibeci, 1989; Freedman 1997), teachers should give particular attention to both student-centred teaching strategies and students' attitudes in science lessons. Traditional science teaching practices diminish students' attitude toward science and achievement in science (Kahle, Meece & Scantlebury, 2000). Therefore, teachers have the responsibility of making the curriculum as relevant and as exciting for students as possible (Trumper, 2006). In this context, project-based teaching activities may provide great opportunities to students for effective science learning, and eventually to enhance positive attitudes towards learning science.

In conclusion, this study supports the view that project-based learning is an effective and motivating strategy for students. 2004 Turkish primary school curriculum was prepared in the light of the constructivist theory, and emphasizes the common use of student-centered and inquiry-based approaches in science courses. Furthermore, Turkish curriculum like the other curriculum design projects in the world requires students to engage in authentic science learning experiences in which students engage in inquiry-based research projects with interesting questions Moje et al. 2001). This situation increases the responsibility of teachers in science courses in order to provide students more enjoyable and effective science learning environments through project-based activities e.g. building student-centered, cooperative, critical, investigative, communicative and interactive learning experiments. However, as Tal, Krajcik and Blumenfeld (2006) emphasized, teachers' content knowledge and pedagogical skills are necessary for successful implementation of new practices, but not sufficient for science education reform. Teachers usually continue to teach in their traditional manner even though they use new textbooks and materials. Therefore, science teachers should be encouraged and supported to practice inquiry-based approaches, especially project-based science teaching to improve success of reform efforts at schools in Turkey or elsewhere (Schneider, Krajcik, Marx, & Soloway, 2002). In science courses, well-designed and well-implemented project-based learning experiences may be a significant catalyst to gain students critical thinking and problem solving kills, and finally to train them as scientifically literate individuals in accordance with the science curriculum requirements of 21st century.

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Applying Blended Learning with Creative Project-Based Learning: A Case Study of Wrapping Design Course for Vocational High School Students

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Abstract: This study aims to investigate vocational high school students' learning effects and learning satisfaction toward the Wrapping Design course with a combination of blended learning and creative project-based learning. A total of 44 students from the Advertising and Design Course participated in this study and they were divided into 11 teams to conduct gift wrapping design activity. The blended learning in this study combined the traditional in-class instruction and a self-designed online learning platform for the students to discuss and share their ideas and related information. The learning process included teamwork, project-based learning, the inquiring-thinking-doing-evaluating, and the 12 creativity tactics. Data collected from the self-developed satisfaction survey questionnaire, online learning platform, classroom observation, learning portfolio, and finished products were analyzed. The findings of this study reveal that the ideal teaching model for applying blended learning with creative project-based learning should contain seven stages. Additionally, key factors such as the teacher's guidance, the practice of creativity teaching methods, teamwork, and online resources can influence learners' performance and learning effects. Finally, this blended learning approach not only can make up the shortcomings of the traditional in-class learning, but also enhance the learners' skills in independent learning, problem solving, and communication.

Keywords: blended learning, creative teaching, project-based learning, vocational high school students, wrapping design

Introduction

In the past years, creative and cultural industry has gradually become one of important global industries. In order to catch up this new trend, Taiwan government has been actively promoting cultural creative industry. However, a successful cultural creative industry heavily relies on high quality creative talents and the teaching mode and quality are the two fundamental factors for cultivating such talents (Lu & Lin, 2005). Thus, one of the best ways to educate students to possess problem solving skills is to design a student-centered environment connecting with various subjects. When students focus on solving problems, their learning motives increased (Brab & Landa, 1997; Zhi & Chuang, 2003). Lou, Chung, Dzan & Shih (2012) mentioned that if school can actually provide students hands-on experience and sense creativity, their creativity can be inspired. In today's increasingly competitive market, wrapping design plays an

important role in the enterprise development, and the demand for packaging design talent is also increasing. On the other hand, in terms of the design industry's talent needs, Lu and Lin (2005) pointed out that the design talents' design expertise is the most important factor, followed by the ability to solve problems, and teamwork, and professional and technical ability. Therefore, this study aims to (1) explore students' learning effectiveness and satisfaction; (2) develop the blended creative project-based teaching model; and (3) providing useful suggestions for the implementation of vocational high school packaging and design course.

Literature Review

With the vigorous development of information technology and the advents of various forms of digital learning tools, teaching methods need to be in response to different teaching environments or mixed medium of instruction. Blended learning integrates formal and informal learning, face-to-face and online learning, self-directed learning, and digital reference resources and connecting with group members (Lou et al, 2010; Shih, 2010; Shih; 2011; Shih; 2012; Rossett & Frazee, 2006). Past studies show that blended learning has the following characteristics: (1) pedagogical richness, (2) access to knowledge, (3) social interaction, (4) personal agency, (5) cost effectiveness, and (6) ease of reversion. From the above mentioned, blended learning not only integrates the benefits of face-to-face and online teaching environments, but also the teachers can identify the most suitable teaching mode in a blended learning environment (Osguthorpe & Graham, 2003; Kose, 2010).

Project-based learning (PBL) is a systematic teaching approach, which emphasizing on students learn knowledge and practical skills through exploring complex life issues and well-planned learning tasks (BIE, 2007). Through living and learning project to integrate different disciplines of curriculum and carefully arrange complex, and real tasks to design motivation enhancement and cognitive strategies to create a peer cooperative learning environment and conduct inquiry-based learning activities, so that the students can acquire problem-solving knowledge and skills (Li, Lou, Chu, & Liu, 2009). Through project-based learning, students will be able to find their own interests and thus to trigger their independent learning motivation (Nastu, 2009; Kose, 2010).

Creative teaching refers to teachers can adopt diverse, active, and rich content to stimulate students intrinsic learning interest to cultivate their attitude of willing to learn and thus to enhance their learning ability (Wu, 2002). In this study, creative teaching was integrated with blended creative project learning, and its teaching process included Chen's (1990) ATDE (Asking-Thinking-Doing-Evaluation) create thinking teaching model, Lin's (2004) creative teaching model, and the 12 "creative tactics." expect to allow students willing to think and learn, and to further enhance its ability to create and creative thinking teaching strategies.

To summarize the above-mentioned literature review, this study aims to apply blended creative project-based learning to the Wrapping Design course of a vocational high school. During the teaching process, creative teaching, project-based teamwork learning, and strategies for blended learning and digital learning system will be merged into the curriculum to further enhance students' performance and

creativity to achieve the teaching goals.

Research Method

Case study, observation, and questionnaire survey were administered in this study. The seven phrases, including preparation, situation observation and raising questions, guiding discussion and confirming questions, generating creative proposal, implementing creative proposal, outcome presentation, and evaluation from the blended creative project-based learning model were introduced to the teaching sessions. The implementation of the study included blended teaching combining digital learning and traditional in-class instruction, teamwork and situated guidance project-based learning, ATDE, and the 12 creative tactics.

Participants

A total of 44 students enrolled in the Wrapping Design course rom a vocational high school in southern Taiwan were divided into 11 teams and participated in this study. The teaching experiment lasted for 12 weeks.

Research Instruments

The research instruments contained the Learning Effectiveness Checklist, the Learning Satisfaction Survey Questionnaire, Student's Learning Observation Record, and the Online Learning Platform. The

1. Learning Effectiveness Checklist: design creativity, box structure, and visual perception were evaluated.
2. Learning Satisfaction Survey Questionnaire: it contains four domains, including teaching and course arrangement, online learning platform, learning attitude, and learning fulfillment. A total of 27 questions in a five point Likert scale and 3 open-ended questions in the questionnaire.
3. Student's Learning Observation Record: includes in-class observation and learning platform observation.
4. Online Learning Platform: contains course information, discussion forum, message board, blogs, bulletin board, downloads, and small group discussion areas, etc. Figure 1 shows the entry page of the online learning platform.

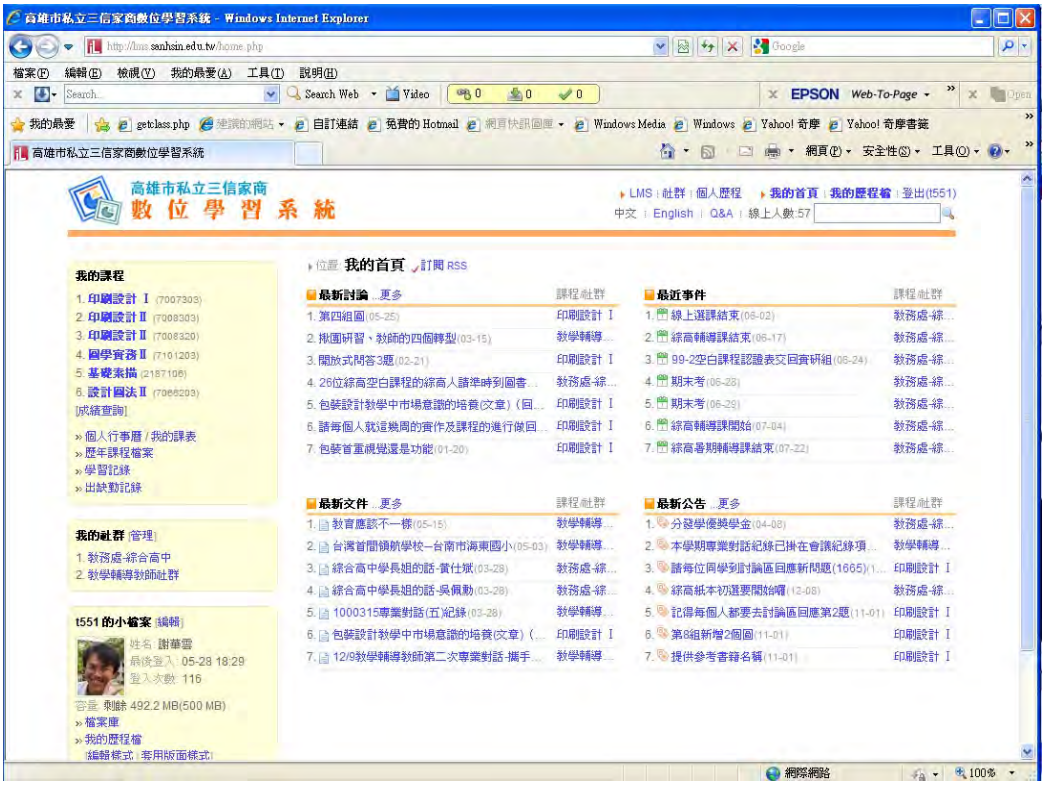

Fig. 1 The entry page of the online learning platform

Data Analysis

All quantitative data collected from the survey questionnaires were analyzed by SPSS 12.0 descriptive statistics, t-test, and One-way ANOVA.

Results and Discussions

The following section depicts the top three students' works, the three teachers' assessments on the top three products of the students work, and the analysis of students' responses to the survey.

1. The descriptions of the top three student s' works

Table 1 shows the descriptions of the top three students' works. After the completion of the works, the three teachers' assessed and scored all the 11 teams' works. Finally, Teams 5, 3, and 10 ranked the top three prizes.

Table 1 The descriptions of the top three students' works

Team	Name of Work	Description	Photo
Team 3	Candy Box	This box is designed for candy. It also can be used for cookies and chocolate. The special feature of this box is a bear with two arms holding up the box. The inner box is a 3 layer design. The color of the box is light yellow.	
Team 5	Canned Food Box	This box is designed for canned food. The inner box is a 2 layer design. The color of the box uses read and purple colors to represent luck and joy.	 
Team 10	Cake Box	This box is designed for rectangle-shaped honey cake. The major box contains 4 small boxes. Each box is a 2 layer design. The four boxes represents the four seasons decorated with the seasonal flowers.	 

2. The three teachers' assessments on the students' works

Table 2 The Statistical results of the three raters' scores

N	Kendall's W (a)	Chi Square	df	Sig.
3	.964	28.911	10	.001

Table 2 shows the three teachers' scores on the students' works obtained a .963 of Kendall ω coefficient correlation, chi-square=28.894, p=.001<.05, indicating the three teachers' scores are significantly related and consistent. That is, Team 5 ranked top one, followed by Team 3 and Team 10.

3. Analysis of students' responses to the survey questionnaire

Tables 3 to 6 show the statistical results of the four domains of the students' responses to the survey.

Table 3 Statistical results of the teaching and course arrangement domain

Item	Statement	Mean	SD	t value	Sig.
a1	In the beginning, the situated guidance and description can enhance my learning motivation.	3.93	.73	8.49	.000
a2	The teaching materials and samples can help me learn faster and easily.	3.98	.72	8.63	.000
a3	The instructor's guidance and assistance can help me stay on the right track for learning.	4.29	.60	13.75	.000
a4	The course design and assignments are appropriate.	3.66	.82	5.11	.000
a5	Teamwork can help carry out the project smoothly.	4.09	.92	7.67	.000
a6	Creative thinking approach and strategies can help me solve problems.	3.92	.75	7.86	.000
a7	I have learned a lot from observing other teams' works and presentations. ◦	4.00	.707	9.06	.000
a8	The teaching methods enable me to think critically.	3.93	.69	8.66	.000
a9	The teaching methods enable me to learn actively and aggressively.	3.63	.73	5.53	.000
a10	I am satisfied with this course.	3.64	.81	5.21	.000

Test value=3

According to Table 3, a1 to a10 are the questions from the teaching and curriculum domain, which obtained means greater than 3 with p=.000<.01. Particularly Item a3 "The instructor's guidance and assistance can help me stay on the right track for learning" obtained the highest mean of 4.29 and item a9 "The teaching methods enable me to learn actively and aggressively" obtained the lowest mean of 3.63. These results suggest that the instructor's proper guidance and assistance to students are necessary and helpful to the students' learning. Meanwhile, it could be because this typed blended creative teaching is new to the students, which was contrary to the traditional in-class instruction, the students need more time to get used to and adjusted to this new type of instruction.

Table 4 Statistical results of the online learning platform domain

Item	Statement	Mean	SD	t value	Sig.
b1	I like to share ideas on the platform or discussion forum.	3.66	.68	6.43	.000
b2	Through online learning platform, my learning interest is enhanced.	3.66	.64	6.78	.000
b3	Interacting with others in the discussion forum can inspire my creative thinking.	3.84	.64	8.65	.000
b4	Through online learning platform, I like to explore more issues and topics.	3.75	.58	8.64	.000
b5	Online learning platform can assist our team learning.	3.72	.85	5.71	.000
b6	I am satisfied with learning through online learning platform.	3.89	.69	8.53	.000

Test value=3

According to Table 4, b1 to b6 are the questions from the online learning platform domain, which obtained means ranging from 3.66 to 3..89 (p=.000<.01), indicating the students are satisfied with learning through the online learning platform. Although the mean scores of the 6 items are close, showing that the students are moderately satisfied with the platform. In the future, more effective and interesting teaching approaches and materials can be added to the online learning platform to increase the students' satisfaction if use.

Table 5 Statistical results of the students' learning attitude domain

Item	Statement	Mean	SD	t value	Sig.
c1	I can communicate well with my team members and work harmoniously.	4.18	.87	9.01	.000
c2	I can actively participate in small group discussions and knowledge sharing.	4.27	.54	15.52	.000
c3	I always actively seek for teacher or classmates help while designing wrapping box.	3.89	.69	8.53	.000
c4	I am willing to spend more time and efforts to collect and analyze data and work in order to solve encountered problems.	3.86	.73	7.80	.000
c5	I am more serious and diligent in learning this course than other courses.	3.77	.83	6.17	.000

Test value=3

According to Table 5, c1 to c5 are the questions from the students' learning attitude domain, obtained means ranging from 3.77 to 4.27 ($p=.000<.01$), indicating the students possess positive and active learning attitude toward this blended creative learning. Particularly, item c2 "I can actively participate in small group discussions and knowledge sharing" obtained a high mean of 4.27, indicating the students were able to actively participate in the group discussions and sharing knowledge.

Table 6 Statistical results of the students' learning fulfillment domain

Item	Statement	Mean	SD	t value	Sig.
d1	Combining traditional in-class instruction with blended learning and online learning platform can increase my understanding to wrapping design practice.	4.00	.75	8.88	.000
d2	This blended creative project-based learning can help groups design and produce their works nicely.	3.84	.68	8.20	.000
d3	Through teamwork to complete the task brought to me the sense of fulfillment.	3.82	.79	6.91	.000
d4	I will be very capable and confident about collecting wrapping design related information in the future. ◦	4.00	.68	9.73	.000
d5	I will be able to analyze and solve wrapping design related	3.82	.62	8.75	.000

	problems in the future.				
d6	I am very confident in creative design practice after taking this class.	3.98	.59	10.98	000

Test value=3

According to Table 6, d1 to d6 are the questions from students' learning fulfillment domain, obtained means ranging from 3.82 to 4.00 (p=.000<.01), indicating the students possess high fulfillment toward this blended creative learning. Particularly, items d1 "Combining traditional in-class instruction with blended learning and online learning platform can increase my understanding to wrapping design practice" and d4 "I will be very capable and confident about collecting wrapping design related information in the future" obtained the highest mean score of 4.00, revealing that the students feel confident and capable about doing wrapping design through this blended creative project-based learning.

To conclude, all the students possess positive and active learning attitude toward this blended creative project-based learning. Through the online learning platform, the students were able to discuss and share ideas and knowledge with others, which enabled the students become more confident and capable in making wrapping design.

Conclusion and Suggestions

The findings of the study show that the students are satisfied with this new learning approach for wrapping design course through blended learning. The students not only can access and obtain various resources in-class instruction but also from online learning platform. Also, project-based learning provides the students teamwork opportunity to stimulate creativity and design ideas as well as to solve problems. Through the online learning platform, the students became more independent and confident. Additionally, the students' learning motivation is enhanced through this blended creative project-based learning. Finally, the creative teaching approach brings different aspects to the wrapping design course and makes the course more joyful and effective.

The following are the suggestions for improving the wrapping design course. First of all, group member's teamwork should be emphasized and balanced, and their feedback and comments should be fully discussed and responded in order to run the course effectively. Second, the students' drawing ability should be reinforced before the class. If the teacher can provide at least two to three weeks for drawing, the teaching would be more effective. Finally, the blended creative project-based teaching and the online learning platform can be applied to various instructions of subjects to enrich the teaching content and enhance the students' creativity.

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Behavior of *Staphylococcus aureus* in a cheese produced by local lactic acid bacteria

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Abstract: *Staphylococcus aureus* is a pathogenic bacterium that infects the milk and dairy products including cheese, causing food borne infections in humans. The objective is to scrutinize the growth and evolution of *S. Aureus* in cheese made with lactic acid bacteria isolated from local plants that are *Lactococcus lactis subsp. cremoris* and *Lactococcus lactis subsp.lactis* biovar *diacetylactis*. In the first part, the milk that was used in the manufacture of cheese was contaminated with *Staphylococcus aureus*, the antimicrobial activity was studied *vis-à-vis S. aureus* and the antagonistic effect of the latter against the lactic strains. In the second part, we performed counts of *lactococci* and *S. aureus* as the contaminated cheese in various stages of cheese production. From contaminated milk before manufacture of cheese, we have noticed a steady decline of lactic ferments after curdling and in parallel we have seen a decrease in the number of *S. aureus* during the early stages of production to increase again in the salting. The results of contaminated cheeses after their manufacture revealed a significant decrease in lactic strains and the pathogenic strain in both types of cheese after 24 and 72 h of their contamination.
Lactococci don't have inhibitory activity *vis-à-vis S. aureus*, and *S. aureus* did not inhibit lactic strains used in the manufacture of cheese. Thus, it preserves its contamination and poses a risk to human health.

Key words: *Staphylococcus aureus*, Contamination, cheese, local lactic acid bacteria.

Introduction

The lactic bacteria have presented a very crucial role in the manufacture of food fermented such as cheese for several centuries. The cheese is a complex medium made up mainly of water, coagulated proteins and milk fats in which, , the pH, the activity of water, the potential of oxydoreduction, the content of salt and the activity of the micro-organisms present in the leavens used, constitute a form of protection against the pathogenic ones. *Staphylococcus aureus* is a pathogenic bacterium which contaminates milk and the dairy products whose cheese, and for this reason it presents a major concern for animal and human health throughout the world. In certain contexts where lactic bacteria are the normal dominant microflore, as in cheese, *S. aureus* colonizes it sometimes and expresses the factors of virulence and produces a food poisoning. This study is devoted to manifest the interaction between the lactic acid bacteria and *S.aureus* and to show the capacities of inhibition which the lactic acid bacteria could have on the growth of S. *aureus* in the event of contamination milk which is used to produce cheese or its contamination after its production.

Materials and Methods

Material

Biological material

- **Milk**

Milk which has been used is a cow milk of the Montbeliard French race having 4 years old. It was selected following the selections carried out on several samples intended for the manufacture of cheese.

- **Rennet**

Commercial Rennet powder of forces 1/100.000 to 720 mg of Chymosine/100g. The powder of rennet is safely preserved from the light and moisture.

- **Lactic acid bacteria**

The lactic acid bacteria used are isolated starting from fermented plants (carrots, olives and cabbages) and identified at the local natural laboratory of Bioressources of the Faculty of Science of the university Hassiba Ben Bouali , Chlef, Algeria , they are *Lactococcus lactis subsp. cremoris* and *Lactococcus lactis subsp. lactis biovar diacetylactis.*

- ***Staphylococcus aureus***

The strain of *S.aureus* used, was isolated and identified at the local natural laboratory of Bioressources of the Faculty of Science of the university Hassiba Ben Bouali, Chlef, Algeria, starting from red Meat of cows.

Culture media

M17 broth and gelose (ref.: FABRI ms) For the preparation of the inoculum and the enumeration of the lactococci. For *Staphylococcus aureus,* we used the nutritive Broth (ref.: Pasteur institute of Algiers) for preparation of pre-culture, Giolitti Cantoni (ref.: Pasteur institute of Algiers) for enrichissement and Chapman medium (ref.: Pasteur institute of Algiers) for the enumeration of *Staphylococcus aureus*.
For the interaction between the lactococci and *S.aureus* Mueller-Hinton media (ref.: FABRI ms) is used.

Methods

The examination of the purity of the bacteria

The examination of the lactic bacteria is done by macroscopic and microscopic observations: the colouring of Gram and search for catalase are used. The scrutiny of *S.aureus* is made by macroscopic and microscopic observations, search of catalase and test of mannitol mobility.

For the transplanting of the lactic bacteria 1 mL of inoculum is ensemenced in 09 mL of milk. Homogenize and well sealed the tubes then incubated at 30 °C during 72 h.

For *Staphylococcus aureus* add 15 mL of a Potassium Tellurite solution to the medium of Giolitti Cantoni, and mix carefully. Carry aseptically 1 mL by dilution of *Staphylococcus aureus* in a sterile tube. Mix the medium and the inoculum.

The incubation is done with 37°C during 24 to 48 hours. Be presumed positive the tubes having transferred to black. To make sure that it is required a development of *Staphylococcus aureus,* these tubes will be the subject of a confirmation by isolation on Agar Chapman previously melted, casting petri dishes and thoroughly dried. Chapman boxes thus seeded will be incubated in their turn with 37°C during 24 to 48 hours. After this time to locate the suspect colonies with knowing the colonies of average size, smooth, brilliant, pigmented in yellow and equipped with a catalase and a coagulase.

Study of the antimicrobial effect of *Lactococcus sp.* on *Staphylococcus aureus*

***In vitro* study**

- Preparation of the pre-cultures

The lactic acid bacteria are ensemenced in tubes which contain 09 mL of M17 broth. The tubes are incubated during 24 h with 30 °C. *S.aureus* is inoculated into a tube containing 09 mL of nutritive broth; this tube is then incubated with 37° C during 24 h - 48 h.

Methods of interaction of *the L actococcus sp.* and *Staphylococcus aureus*

The interaction is tested according to the method of Tadesse *et al*. (2004) known as a disc method or carries germ, and that was made in two manners. Firstly, discs are impregnated *by S.aureus* and the lactic acid bacteria are cultured on agar, and secondly, the discs impregnated by the lactic acid bacteria and *S.aureus* ensemenced on agar.

Manufacture of cheese contaminated by *Staphylococcus aureus*

Raw materials

- **Preparation of milk**

14 g of dried milk is dissolved in 100 mL of distilled water, and then pasteurized in a Marie bath regulated with 75°C during 15 to 20 minutes. After that, milk is cooled at 37°C.

- **Preparation of the inoculum**

  Ensemence some colonies of lactic acid bacteria "*Lc. lactis subsp cremoris* and *Lc. lactis subsp lactis biovar diacetylactis* " in prepared milk (each strain in a bottle). Homogenize and well seal the bottles then incubate with 30°C during 24 hours.

- **Preparation of lactic ferments.**

Prepare o milk (dried milk 14g in 100 mL of distilled water); Take 2 mL of inoculum prepared in 100 mL of prepared milk then incubates at 30°C during 16 to 18 hours.

- **Preparation of the solution of rennet**

Dissolve 1g of rennet powder in 100 mL of distilled water and preserve at 4°C during one week in maximum.

- **Preparation of dilutions of the inoculum of *Staphylococcus aureus***

We aseptically take using a graduated pipette 1 mL of inoculum and introduce it into a sterile tube containing 09 mL of physiological water, this solution is regarded as dilution 10^{-1}, with the same method, one obtains dilutions 10^{-2},10^{-3}.

Stages of the manufacture of cheese

We conducted two ways: Prepared Cheese starting from milk contaminated by *S.aureus* and Cheese preparation then its contamination by *S.aureus*.

a/ Preparing cheese starting from contaminated milk by *S.aureus*

- **Curdling**
  - **Cheese of the lactic type**

- Pasteurize 1 liter of cow's milk in a Marie bath regulated in 75°C during 15 to 20 minutes;
- Cool the milk until the 30 - 37°C.
- Add 15 mL of lactic leaven of types *Lc. lactis subsp cremoris* and 15 mL of lactic leaven of type *Lc. lactis subsp lactis biovar diacetylactis;*
- Ensemence milk by 1 mL of dilution 10 -3 of the inoculum of Staphylococcus aureus;
- Homogenize and well seal the container;
- Leave the curdled milk at a temperature of 25°C during approximately 16 to 18 hours;

  - **- Cheese of the mixed type**

- Cheese curdling of the mixed type is identical to the first type of cheese, by adding 0,4 mL (1g/100 mL) with the solution of rennet for 1 L of milk;
- Ensemence milk by 1 mL of dilution 10^{-3} of the inoculum of *Staphylococcus aureus;*
- Homogenize and well seal the container;
- Leave the curdling milk at a temperature of 27°C during approximately 16 to 18 hours;

- **Draining**

- After the coagulation of milk, put the curd on a filter;

- Leave curd drained spontaneously during 24 hours;
- Recover the lactoserum;

- **moulding**

- The curd is put out of mould after 24 hours of draining;
- Make the 1 st reversal of the curd;
- After 12 hours, make the 2 nd reversal.

- **Salting**

- The curd is put in brine (6.5 % of NaCl) during 10 to 20 minutes;
- Follow-up of a final draining (24 hours at 18°C).

- **Refining**

-The refining and the conservation are 10 to 12 days at 14°C

b/ Contaminated cheese by *S.aureus* after its manufacture

Cheese of a lactic type and cheese of a mixed type with a concentration of 6.5% of NaCl are prepared with the same manner and they are contaminated after 10 days of conservation by *S.aureus.*

Enumeration of the lactic acid bacteria and *S.aureus*

The enumeration of the lactic flora and *S.aureus* is done along the principal stages of the manufactoring process of the cheese (initial Load of the inoculum, Curdling, Draining, moulding, draining, Salting, Refining, Cheese before contamination, Cheese after 24 h of contamination and 72 h of contamination). The enumerations are carried out for the two types of cheeses (lactic and mixed).

Results and discussion

Testing of the purity of the bacteria

a/ The lactococci

All the taken colonies starting from M17 are round or lenticular, with regular contours, white, opaque and smooth, indicating that there are the lactococci as was confirmed by Leveau and Bouix (1980), Guiraud (2003) and Badis *et al.* (2005).

After Gram colouration , the microscopic examination allowed us to notice the aspect of the cells and their mode of regrouping. Only the positive Gram bacteria are retained. The microscopic aspect of all the strains used is presented in the form of shells, as Guiraud (1998) indicates it. The lactococci ones do not have a catalase, which is confirmed by Guiraud (2003).

b/ *Staphylococcus aureus*

During the macroscopic identification of *S.aureus* on Chapman medium, the insulated colonies appear in the form spherical of gilded yellow color, with a regular contour with Catalase + and Mannitol-mobility + as it was indicated by Avril (1997).

The fermentation of the mannitol results in the appearance of a yellow color due to the acidification of the medium. The mobile bacteria produce disorders in the medium and the motionless bacteria persist meadows of the central puncture (Guiraud, 1998). Thus *S.aureus* ferments in anaerobiose the mannitol and it is motionless.

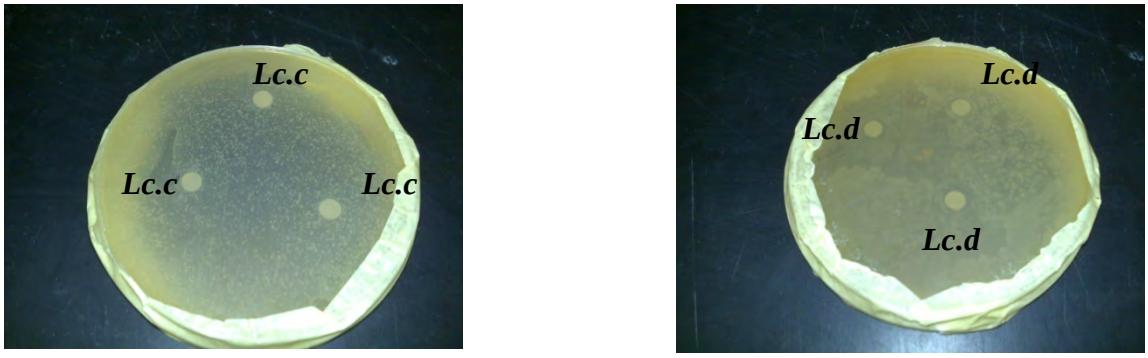
According to the results, we can deduce that it is about the *S.aureus* germ. These results are sustained by those of Baird Parker taken by Guiraud (1998).

Interaction of the *lactococcus sp.* and *staphylococcus aureus (in vitro)*

Inhibition of *S.aureus* by *lactococcus sp.*

According to the results obtained, no effect was noted, the pure cultures and the mixed cultures of lactococci do not have an inhibiting activity on S.aureus (figures 1and 2).

This result is not in agreement with the work of Schillinger and Lucke (1989) which revealed that the lactococci ones have an inhibiting activity, *in vitro*, of the strain of *S.aureus*. This difference is probably related to the origin of the local lactic acid bacteria which are isolated starting from the plants (carrots, cabbages and olive black) where the ecological niche is not the same one. In the same context, the work of Yuksekdag *et al.* (2004) manifest the capacity of lactococci to inhibit *S taphylococcus aureus in vitro*.



(A) (B)

Figure 1: Antibacterial activity of the pure cultures of *Lc. cremoris* (A) and *Lc. diacetylactis* (B) with *Staphylococcus aureus*.

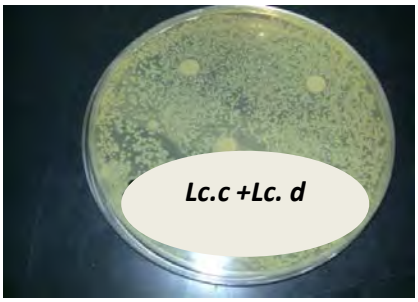
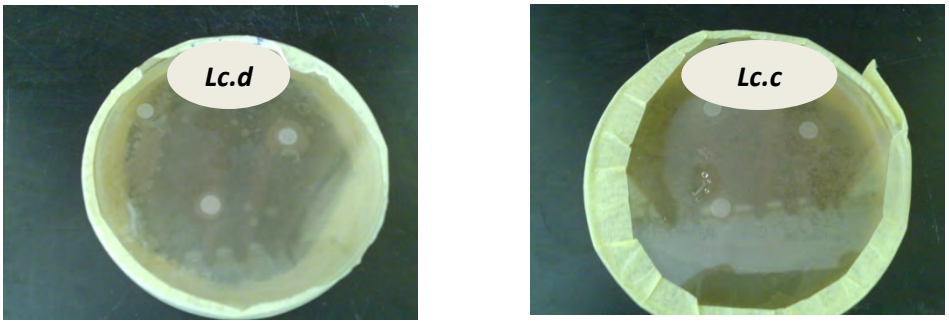


Figure 2: Antibacterial activity of the mixed cultures of *Lc. cremoris* + *Lc. diacetylactis* with *Staphylococcus aureus.*

Inhibition of *the lactococcus sp.* by *S.aureus*

When the discs were impregnated with *S.aureus* and the lactococci ones were spread out over the agar, we noted that there is no inhibition of lactococci by *S.aureus* (figures 3 and 4), which confirms that the lactococci ones used in the majority of the cases as probiotic against the pathogenic persons in charge for gastroenteritis are not inhibited by the latter what is confirmed by the former work of Luquet and Corrieu (2005) which showed that the intestinal lactic flora is a first line of defense which oppose to the microbes and the other infectious agents.



(A) (B)

Figure 3: antibacterial Activity of *Staphylococcus aureus vis-à-vis* of pure cultures of *Lc. cremoris* (A) and *Lc. diacetylactis* (B).

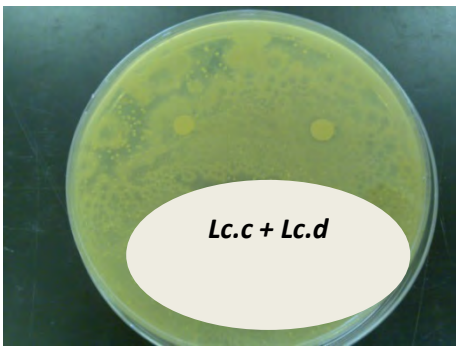


Figure 4: Antibacterial activity of *Staphylococcus aureus* on the mixed cultures of *Lc. cremoris* + *Lc. Diacetylactis*

Interaction of *the lactococcus sp.* and *staphylococcus aureus* in cheese

Prepared cheese starting from a milk contaminated by *S.aureus*

a/ The lactococci

Enumerations of the total lactic flora were carried out after each stage of development of the two types of cheese (lactic and mixed) contaminated by *S.aureus*. After the curdling of milk, the number of cells of the leavens is relatively high with 4.73 x 10^8 cells/mL for cheese of the lactic type and 3.2 x 10^8 cells/mL for cheese of the mixed type. The increase in the leavens is allotted to the substrates which are rich in nutriments for the lactic acid bacteria.

Subsequently and after the moulding and salting, the concentration of the leavens decreases relatively to reach respectively 1.8 x 10^7 cells/mL and 1.83 x 10^7 cells/mL for cheese of the lactic type and 2.75 x 10^7 cells/mL and 2.99 x 10^7 cells/mL for cheese of the mixed type. These results are in agreement with that of Kim et *al.* (1994) who observed a reduction in the population of lactococci in fresh and refined cheeses after salting. Undoubtedly, this is because of their sensitivity to salt, as well as the loss of a certain number of bacteria in the whey after draining. By this token, Mahaut *et al.* (2000) show that the content sodium chloride of milks of cheese dairy can influence the survival of the lactococci ones.

During refining, the number of cells of the leavens increases again to reach 7.06 x 10^7 cells/mL for cheese of the lactic type and 7.17 x 10^7 cells/mL for cheese of the mixed type after 4 days (figure 5). The bacterial concentration remains high after 8 days of refining for the two types of cheese. Then, the number falls again and this is due to the exhaustion of the medium in nutriments during the last days of refining. This result is in conformity with the one that has been found by Eck and Gillis (1997) which demonstrate that an 8 weeks refining to 12°C reduced little the population of lactic bacteria.

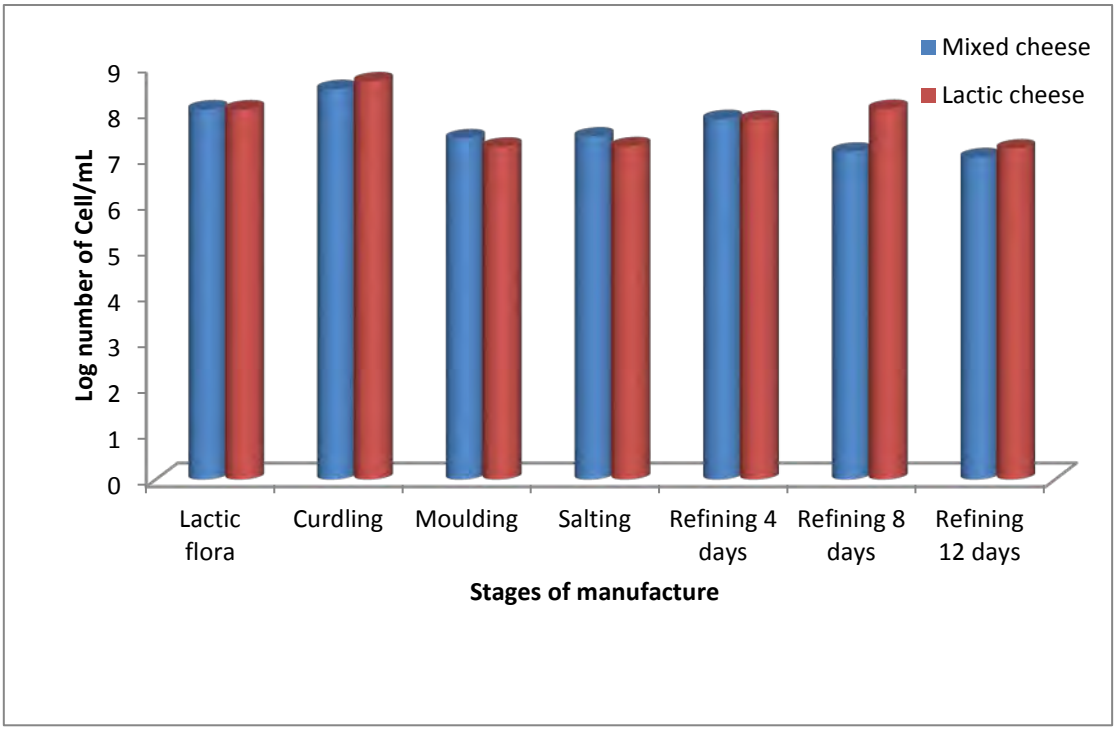


Figure 5: Enumeration of the cheese leavens during the stages of manufacture of cheese contaminated by *S. aureus*

b/ *Staphylococcus aureus*

The enumerations of the cheese ferments were carried out after each stage of development of the two types of cheese (lactic and mixed) contaminated by *S.aureus*. The initial load of *S.aureus* is 2.8 x 10^5 cells / mL in the two types of cheese. The results obtained indicate that the number of *S.aureus* falls considerably during the stages of curdling and the moulding for the two types of cheese manufactured and arrives respectively at 7.05 x 10^4 cells/mL and 6.25 x 10^4 cells/mL for cheese of the lactic type and 7.6 x 10^4 cells/mL and 4.5 x 10^4 cells/mL for cheese of the mixed type (figure 6), this reduction is allotted to the pH of milk. For this very reason, Leyral and Vierling (2007) showed that the lactic acid bacteria ferment lactose and acidify milk because of the massive production of lactic acid. Milk coagulates when the pH reached of the values less than 4.6 which is the isoelectric pH of milk.

Similarly, Hatreds and Hermon (1973) confirm that the inhibition of *S.aureus* by the lactic production of acid must take place after several hours in cheese. According to Gilliand and Speek (1974), antagonism towards *S.aureus* remains obvious when milk is maintained with a pH of 6.5. In the same context Meyrand *et al.* (1999) corroborates that the inhibition of *S. aureus* by the lactic acid bacteria is implemented at the time of the coagulation of milk.

The number of *S.aureus* increases again to reach a value of 6.31 x 10^4 cells/mL in cheese of the lactic type and 1.61 x 10^5 cells/mL in cheese of the mixed type during salting (figure 6). According to Han *et al.* (2005), *S.aureus* is an euryhaline bacterium which is able to multiply in medium of laboratory up to 12% of NaCl.

Throughout refining, we noted a reduction in the number of cells of *S.aureus* in the two types of cheese, which arrives at 1.24 x 10^4 cells/mL for cheese of the lactic type and 1.95 x 10^4 cells/mL for cheese of the mixed type, that can be explained by a proteolytic activity, a reduction in the activity of water (aw), an increase in the environmental temperature or an exhaustion of medium in nutriments.

Mayrand and Vernozy-Rozand (1999) displayed that the population of *Staphylococcus aureus* stabilizes itself or tends to decrease in particular during a long refining. But even after 12 days the number remains significant for a pathogenic bacterium such as *S.aureus* where their pathogenic character is directly related to the presence of toxins and its incidence on human health is only possible from starting from a strong

contamination: 10^6 Staph. / g of cheese, and even the regulation can be regarded as not satisfying a threshold more than 10*4* Staph. / g of cheese.

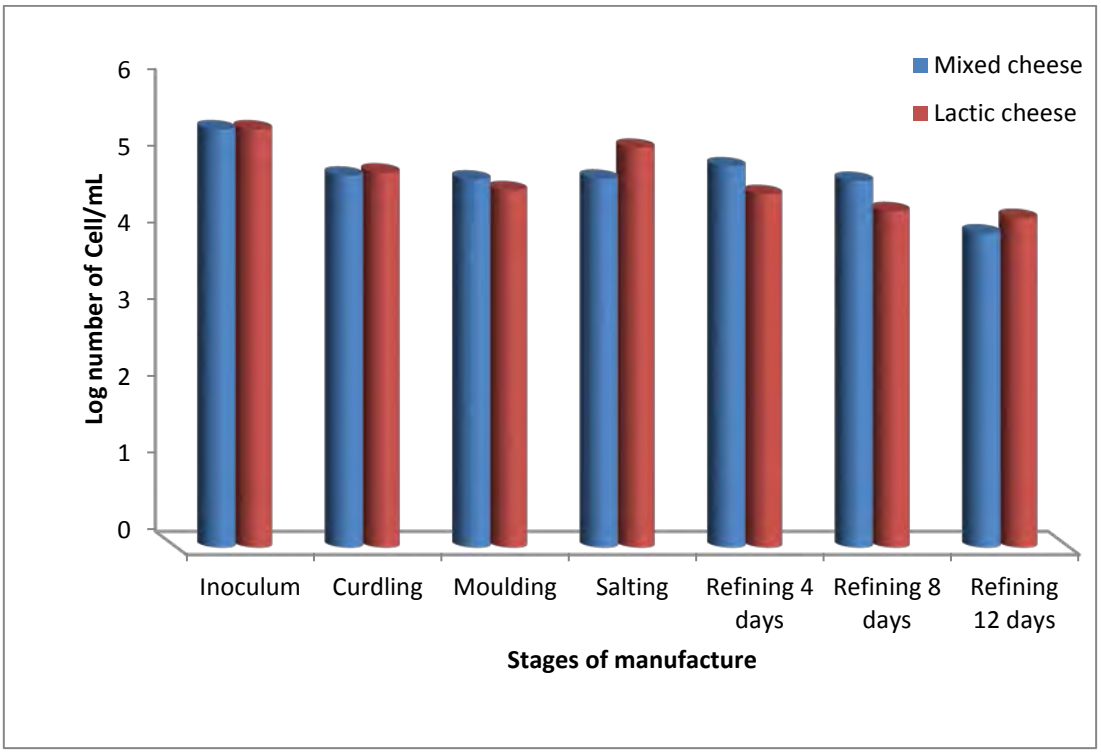


Figure 6: Enumeration of *S. aureus* during the stages of manufacture of cheese contaminated by S. *aureus*.

3.3.2. Cheese contaminated by *S.aureus* after its manufacture

We contaminated the two types of cheese by the *S.aureus* stock after their manufacture then, we carried out enumerations of the lactic strains and pathogenic strain after 24 and 72 hours.

a/ The lactococci

During the storage of cheese with 4°C, a reduction in the number of cells is recorded according to time (figure 7). The concentration reaches 3.36 x 10^7 cells/mL for cheese of the lactic type and 1.11 x 10^7 cells/mL for cheese of the mixed type after 10 days of storage. We noted that the load of the lactic flora decreases in the two types of cheese contaminated by the *S.aureus* strain. According to Bornarel *et al.* (2003) during marketing, the cheese is preserved at the cold, a temperature which has not to exceed 8°C, during 1 month or more. Under these conditions, the leavens of cheese do not multiply, but they, nevertheless, preserve a metabolic activity, the reduction is also allotted to the exhaustion of the medium in nutriments as the competitive effect between the strains.

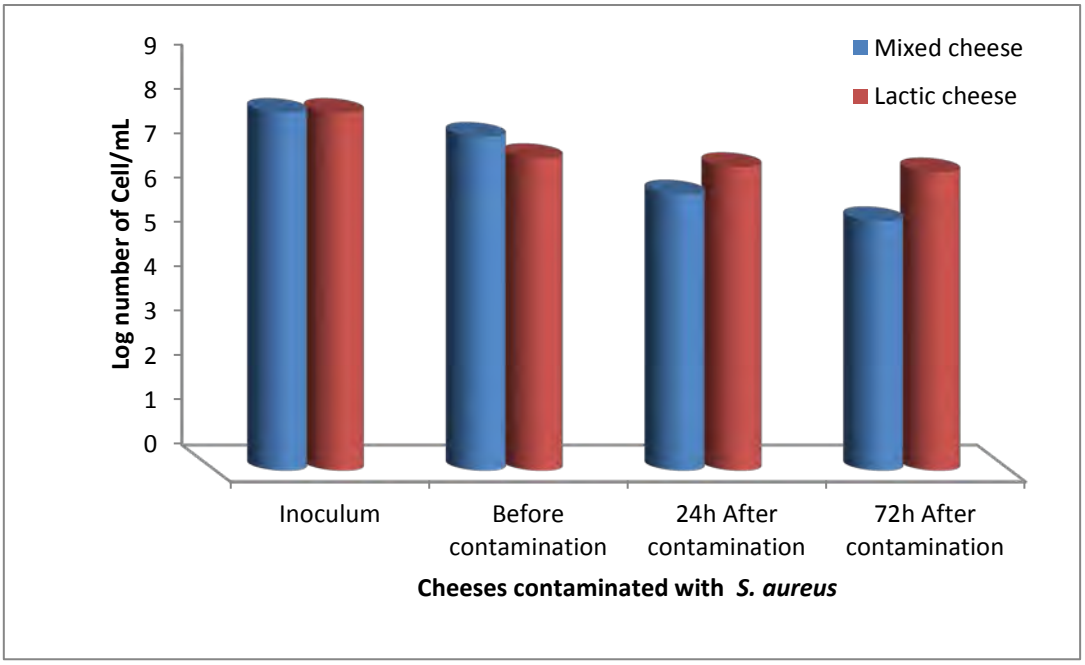


Figure 7: Enumeration of the lactic acid bacteria after the manufacture of contaminated cheese by *S. aureus*.

b/ *Staphylococcus aureus*

Following the results mentioned in figure 8, we observed a continuous reduction in a number of cells of *S.aureus* to arrive at a value of 0.86 x 10^4 cells/ mL in cheese of the lactic type and 0.15 x 10^4 cells / mL in cheese of the mixed type after 72h of their contaminations. According to Cathy (2006), the presence of the lactic acid bacteria in the cheese ecosystems generally operates a barrier effect on the establishment and the growth of *Staphylococcus aureus*. Along the same line of thought, Duquenne (2010) reports those technological agents and factors such as rennet, the leavens of acidification or refining, the mechanical and physical operations, the temperatures of manufacture and the conditions of refining can also influence the growth of *S. aureus*.

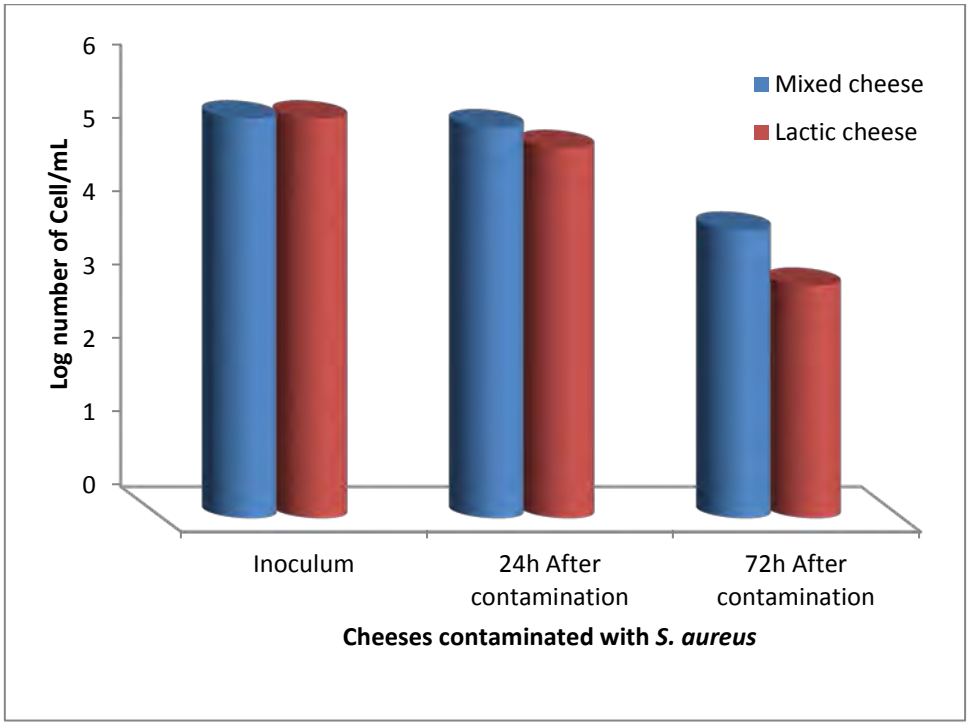


Figure 8: Enumeration of *S. aureus* in cheese contaminated after its manufacture.

Conclusions

The pure and the mixed cultures of *Lc. lactis subsp cremoris* and *Lc. lactis subsp lactis biovar diacetylactis* do not have an inhibiting activity with respect to *S.aureus* , of the same *S.aureus* did not inhibit lactic acid bacteria used *in vitro*.

The enumeration of lactococci and *S.aureus* during various stages of cheese-making manufacture (lactic and mixed) starting from contaminated milk being used to manufacture cheese showed a continuous reduction in the lactic leavens after curdling and in parallel the number of *S.aureus* fell during the first stages of manufacture to increase again during salting and that for both types of cheese.

The study of the evolution of the lactic strains and *S.aureus* in the two types of cheeses contaminated after their manufacture is characterized by a significant reduction in the lactic strains and pathogenic strain in the two types of cheese after 24 h and 72 h of their contaminations. Despite this, the cheese preserves its contamination *with S.aureus* in the course of time and remains a danger to human health.

Acknowledgement

Financial support was received from the Laboratory of Natural Local Bioresources and the University Hassiba Benbouali-Chlef and from Algerian Ministry of Scientific Research.

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Removal of Cationic Dye from Textile Industry Wastewater with Using Enzyme, Fungus and Polymer

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Abstract: It was used significant amount of water in various processes such as dyeing, desizing and bleaching in textile industry. Thus companies have to be faced wastewater problems. Especially in dyeing process different type of colourants -for instance acidic, reactive, basic, disperse, azo, diazo, antraquionone- based and metal complex based - were applied to textiles and as a result it was obtained a huge amount of colourful wastewater from dye process. Due to treatment for these colourful wastewaters it can be applied many different methods such as adsorption, chemical oxidation, coagulation, membrane filtration. In this study, decolorization of cationic dye (Basic Blue 41) from local textile mill was investigated by using Horseradish peroxidase enzyme and sulfonated polymers at different pHs. In addition, removal of the cationic dye also carried out by using *Trametes versicolor* from white root fungus for pH 3,6. Decolorization effiency was high (90 %) with *Trametes versicolor* for 7 days, whereas little decolorization was observed with Horseradish peroxidase enzyme. It was achieved quicker total treatment of cationic dye with using sulfonated polymers in comparison to enzyme and fungus.

Key words: Cationic dye, Horseradish peroxidase, Trametes versicolor, decolorization, sulfonated polymer, adsorption.

Introduction

The textile industry consumes huge volumes of water in different wet processes and as a result it was obtained significant amount of colourful wastewater from dye process. In dying process, various dyes can be used such as acidic, reactive, basic, disperse, azo, diazo, antraquionone-based and metal complex dyes according to fabric types (Tuba et al., 2010).

Dyes present a potential human health risk as some of them have been shown to be carcinogenic. Traditionally wastewater treatment methods can be classified as physical, chemical and biological. Various chemical and physical methods, such as chemical coagulation and adsorption on activated carbon, are being used. However, these traditional methods mainly transfer the contaminants from wastewater to solid wastes, which may lead to a new kind of pollution (Chen and Zhu, 2007; Harazona et al., 2003; Onder et al 2011, Gupta and Suhas, 2009; Crini, 2006).

Medium-size factories can prefer physical and chemical techniques by using coagulants and/or floculates because of economical concerns. However, in spite of biological methods are more complex and unfortunately costly ways, they are most convenient and efficient methods, because total treatment of wastes can be achieved. In addition, to get good results/total treatment and cheapening of costs, various methods can be used together according to characteristic of wastewaters. These combining methods are useful and eligible for non-profit public purposes especially municipalities.

The use of enzymes is currently a possibility for application in environmental engineering, however their purification procedures are too expensive. Enzymes from various sources (fungus and plant based) have been applied for the treatment of dye based compounds. Fungal extracted enzymes have been mostly studied in dye removal processes (Chen and Zhu, 200); Onder et al, 2011; Harazona, 2003).

Table 1: Treatment of some basic dyes by using different methods

Dye/Solution	Method	References
Basic red 46	Electrocoagulation	Daneshvar et al., 2006
Basic Yellow 28	Electrocoagulation	Daneshvar et al., 2006
Basic dye textile effluent	Electrocoagulation	Zaroual et al. 2006
Basic Red 46	Photocatalytic (immobilized TiO_2 nanoparticles)	Khataee, 2009
Crystal violet	Adsorption (activated carbon)	Prasad et al., 2012
Methylene blue	Biosorption (*Trichoderma viride* fungus)	Asma et al 2009
Methylene blue	Superabsorbent hydrogel	Alexander, 2006
Crystal violet, Bismarck brown Y	Adsorption (modified chitosan)	An-Chong Chao et al., 2004
Methylene blue	Lignin peroxidase enzyme	Viridiana et al., 2007
Methylene blue	Adsorption (Hydrogels)	Bajpai et al., 2012
Basic violet 3 Basic red 9	*P. Ostreatus, S. Commune, S. Rolfsii, N. Crassa, Polyporus sp., T. Villosa and M. Thermohila*	Elias et al., 2000
Crystal violet, Basic fuchsin, Brillant gren, Malachite gren	Aeromonas hydrophila strain DN322	Ren et al., 2006
Methyl violet	Adsorption (perlit)	Mehmet and Mahir, 2003

Basic dyes are cationic soluble salts of coloured bases. Basic dyes are applied to substrate with anionic character where electrostatic attractions are formed. Basic dyes are powerful colouring agents. It's applied to polyacrylonitrile, modified nylons, modified polyesters, paper. They are generally water soluble (Gupta and Suhas, 2009).

In the present work, an attempt has been made to examine the efficiencies of various waste treatment methods (enzyme based, microorganism based and polymer based) for colour (Basic Blue 41) removal at different conditions.

Materials and Method

The cationic dye were provided from a local textile mill. Horseradish Peroxidase (E.C. 1.11.1.7) (Mw ~ 40.000 Da) (Fluka), D (+) glucose (Fluka), malt extract (Merck), acetic acid (Fluka), sodium phosphate dibasic (Riedel-de Haen), monobasic sodium phosphate (Riedel-de Haen) and Trametes versicolor were analytical reagent grade and used as received without further purification. In all experiments ultra pure water was used obtained from Millipore MilliQ system. Sulfonated polymers that used in experiments were obtained from Du Pont or synthesized in our lab (Kaya, 2012).

Removal of Basic Blue 41 by Horseradish Peroxidase

Decolorization of Basic Blue 41 (B 41) dye using Horseradish peroxsidase was carried out directly in the spectrophotometer cuvette. The reaction was started by adding buffer solution at different pHs, B 41 dye, HRP enzyme and finally H_2O_2 (3 %) as the initiator in the reaction cuvette (Onder et al, 2009). The final volume of the reaction cuvette was 3.0 mL. Dye decolorization was measured with temperature controlling UV-Vis spectrophotometer (Model UV–1700 Pharmaspec Shimadzu) based on the maximum absorbance at 608 nm in the visible range, at different pHs (5.0, 6.0, 7.0, 8.0) and 30 ^{o}C temperature.

Removal of Basic Blue 41 by *Trametes Versicolor* from White Root Fungi

Culture Medium and conditions: *Trametes versicolor* Strain T (DSM 11309) was maintained on 2% (w/v) malt agar plates. Three cubes of 0.5 × 0.5 cm were transferred to 500-mL Erlenmeyer flasks, which contained 150 mL liquid medium (25,0 g malt extract, 2,0 g KH_2PO4, 0.4 g K_2HPO4; deionized H_2O ad. 1,000 mL, pH 5.5) and were grown in static culture for 14 day under at 30 ^oC (Borchert and Libra, 2001).

Media for dye decolorization: 2,50 g malt extract and 0,10 g glucose dissolved in 100 mL deionized H_2O then pH was adjusted to 3,6 and sterilization at strilazator for 15 min. at 1,2 atm and 121 ^oC (Borchert and Libra, 2001). All steps were performed aseptically with sterile media.

Removal of Basic Blue 41 by Sulfonated Polymers

Basic blue 41 dye was prepared in distilled water. The pH of dye solution was adjusted with 0.1 N NaOH and HCl solution. The pH of solutions was measured with a pH meter. The study was performed in 15 mL tubes with a working volume 5 mL of dye solution different pHs. Tubes were placed in on shaker at 300 rpm at room temperature.

Results and Discussion

Dye decolorization values were calculated according to decreasing of maximum absorbans (608 nm)of the basic blue 41 dye at different incubation times (Figure 1).

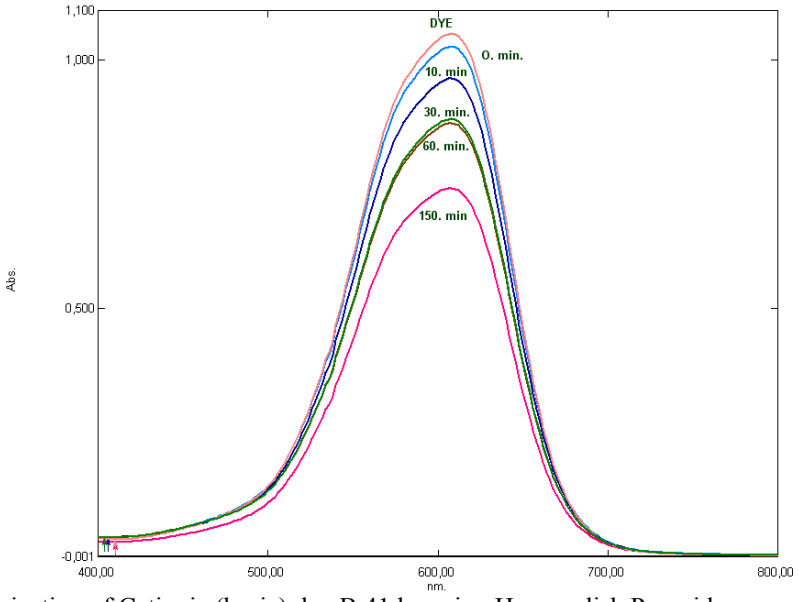

Figure 1: Decolorization of Cationic (basic) dye B 41 by using Horseradish Peroxidase enzyme at pH: 7.0 and 30 ^0C for different incubation time.

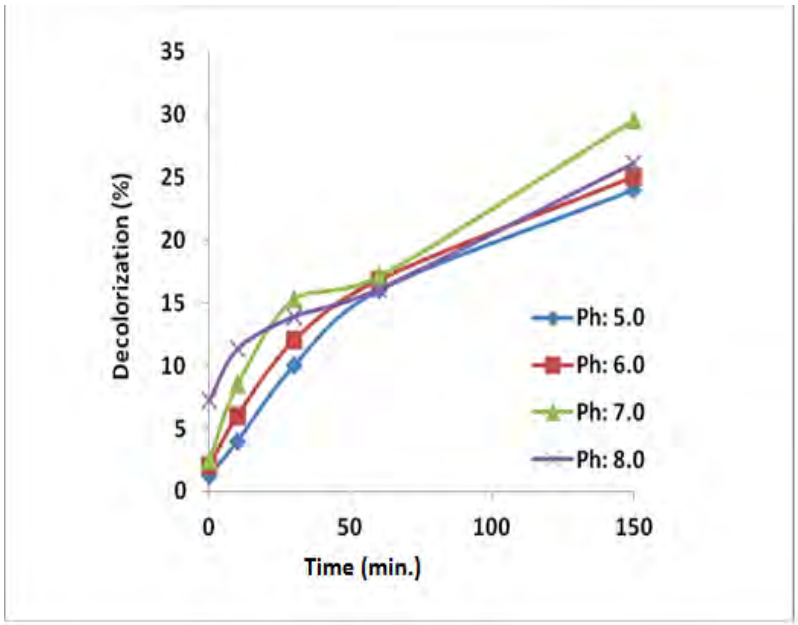

Figure 2: Decolorization (%) of Cationic (basic) dye B 41 by using Horseradish Peroxidase enzyme at different pHs and 30 ^{0}C.

In our previous study, acidic pHs were more effective for decolorization of Naphtol Blue Black (acid dye). Optimum pH of the Horseradish peroxidase enzyme was 5.0 for decolorization of acid dye (Onder et al, 2011). In this study, decolorization values of basic dye was low according to our previous study (acid dye) with the Horseradish Peroxsidase enzyme.

Figure 3: Removal of B 41 dye by using Trametes Versicolor from White Root Fungi at pH: 3,6 and 30 ^{o}C.

B 41 dye was removed 90 % after 7 days by using Trametes Versicolor from White Root Fungi. The microorganism was high removal values at acidic pHs. For this, it was studied at pH: 3,6. Decolorization of Basic Blue 41 was continued for 7 days under shaking conditions at 30 ^{0}C and pH 3,6 using Trametes versicolor from White root fungi.

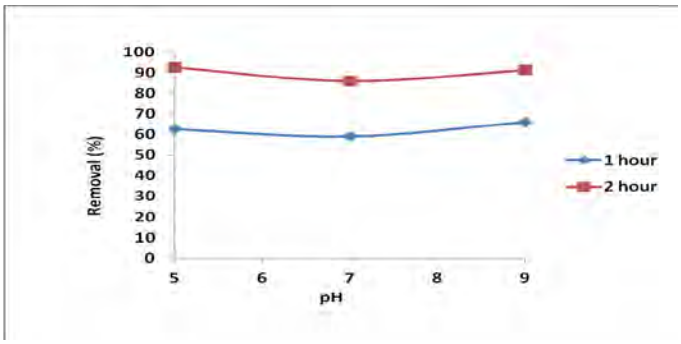

Figure 4: Removal of Basic Blue 41 by using commercial sulfonated polymer at different pHs.

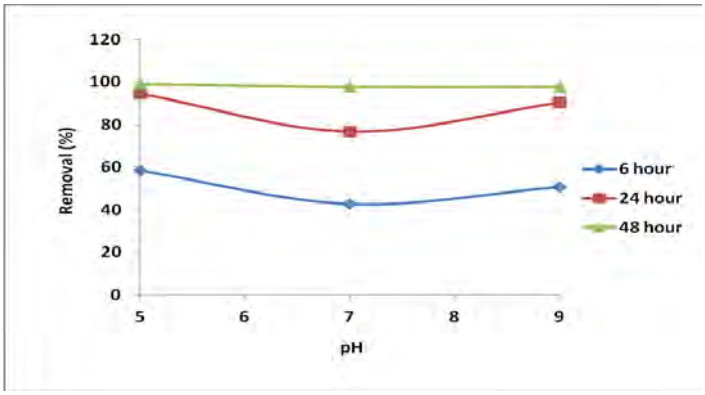

Figure 5: Removal of Basic Blue 41 by using our synthesized sulfonated polymer at different pHs.

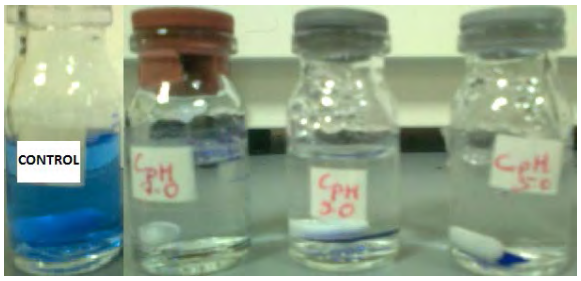

Figure 6: Removal of Basic Blue 41 by using commercial sulfonated polymer after 3 hour.

Figure 7. Removal of Basic Blue 41 by using our synthesized sulfonated polymer after 6 hour.

Sulfonated polymers can easily and quickly adsorp cationic dyes due to carrying structural negative charges. Both sulfonated polymers (commercial and synthesized) exhibit superior removal efficiency relatively in a short time in comparison to other methods (enzyme based and microorganism based). In view of total

treatment time, it has to be noted commercial sulfonated polymer is quicker than synthesized sulfonated polymer.

Conclusions

In the light of experiments, results can be summarized following;

- Dye removal process from wastewaters is strictly depend on pH value.
- Synthetic dye solutions were decolorized in short time (2 h.) by commercial sulfonated polymer. On the other hand our synthesized sulfonated polymer removed dyes after 2 days.
- Decolorization effiency was high (90 %) with *Trametes versicolor* for 7 days, whereas little decolorization was observed with Horseradish peroxidase enzyme.
- Using sulfonated polymers is most convenient and efficient method in among other methods for decolorization of the cationic dye, because of their shorter treatment time and high efficiency.

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Investigation of Changes of Pre-service Teachers' Opinions about Environmental Education with Drawing Analysis

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Abstract: The purpose of this study is to investigate the effects of the project "Nature Education in Ihlara Valley (Aksaray) and Its Surrounding Area III" supported by The Scientific and Technological Research Council of Turkey (TUBITAK) on the pre-service teachers' environmental opinions. Drawings were used to collect data in the present study. Two questions were asked pre-service teachers to determine their opinions about environment and environmental education before the project and at the end of the project: The present study is an attempt to seek answers to these questions asked to pre-service teachers "In what kind of environment do you want to live? Please draw it" and "What kind of environmental education do you want to give to your students? Please draw it". Then, the opinions of the students expressed in their drawings are collected under the suitable categories. The opinions of the pre-service teachers are conceptualized under the emerging categories and tables of frequencies are formed for the concepts.

Key words: drawings, environmental education, pre-service teachers

Introduction

Environmental education is the process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the interrelatedness among man, his culture and his biophysical surroundings (UNESCO-UNEP, 1985). Various environmental education programs (field trips, trekking, camping, and adventure activities) help children to develop effective relations with their natural environment, to improve their sensitivity towards the nature, and their social relations (Palmberg & Kuru, 2000). The importance of summer camps in raising students' awareness of environmental values and learning the natural processes in their natural environments (Dresner & Gill, 1994); and the importance of ecological programs in creating positive changes in their environmental behavior (Bogner, 1998) are emphasized. When groups received information on environmental issues and appropriate action strategies, they showed an increase in environmentally responsible behavior and an increased understanding of environmental action (Jordon, Hungerford & Tomera, 1986; Newhouse, 1990). Direct experience with a variety of environmental action strategies and lifestyles that help to ameliorate environmental problems--such as the use of solar energy to heat water--is also important if students are to learn new behaviors. Role modeling, use of case studies, active participation in an environmental action project, and participation in simulations of environmental issue resolution are all techniques that can develop action skills (Dresner& Gill, 1994).

There are 41 national parks in Turkey (Varnacı Uzun, 2011). Based on the applications in America, nature education was initiated in Termessos, Kackar, Kazdagi, and Goreme national parks within the framework of the project called "Scientific Environmental Education in National Parks" by Land Sea Atmosphere and Environment Research Group of TUBITAK in 1999 in Turkey (Ozaner & Yalcin, 2000; Keleş, 2011). There is a lot of research looking at the effects of nature education programs carried out in national parks on students' environmental knowledge, attitudes, and behaviors. However, the number of studies dealing with in what kind of environment pre-service teachers want to live and what kind of environmental education they want to give to their students is quite limited. Therefore, following two questions were directed to the pre-service teachers before they participated in a nature education program.

-In what kind of environment do you want to live? Please draw it.
-What kind of environmental education do you want to give to your students? Please draw it.

The responses to these questions were sought through drawings. Drawings are a way to find out learners' previous experiences or what they have learnt about a subject (Korkmaz, 2004). Thus, drawings may be effective in providing students with opportunities to improve their observational skills and allowing them to understand the natural world (Dempsey & Betz, 2001).

Materials and Method

Study group

The study group consists of 30 pre-service teachers studying in 4 different departments (preschool education, primary education, social studies, science and physics) of the education faculties of 17 universities who participated in nature education program carried out on 27 August-02 September 2012 with the support of TUBITAK. 18 (54%) of the participants are girls and 12 (46%) are boys.

Activities carried out within the framework of the nature education

With this project, where active learning methods were used, the pre-service teachers were introduced to geological, geomorphologic, floral, faunal and cultural features of the natural environment and to the problems stemming from the mass tourism activities taking place in the region. In this respect, some field studies were carried out on the volcanic structure around Ihlara Valley and Hasan Mountain. Besides field studies, some activities in a classroom setting were also carried out. In the classroom setting, creative drama activities were performed for the pre-service teachers to get to know each other and take individual responsibilities.

Data collection instruments

The present study consists of two parts. In the first part, what was expected from the pre-service teachers was to think about their dream environment where they want to live and then draw what they thought. In the second part, the aim was to elicit the opinions of the pre-service teachers about the environmental education they are planning to give in the future. For this purpose, the same questions were asked on the first and last days of the study.

Data analysis

The opinions emphasized in the drawings of the pre-service teachers were separately conceptualized by the researcher. Then the tables of frequencies showing how many times a concept was repeated by the students were formed. Then, the conceptualizations of the researchers performed separately were brought together to subsume them under common categories. The data obtained in this way were then interpreted.

Results

In this section, the pre-service teachers' opinions about environment and environmental education are presented before and after the nature education they were involved in:

The Pre-service Teachers' Opinions about Environment and Environmental Education before Nature Education

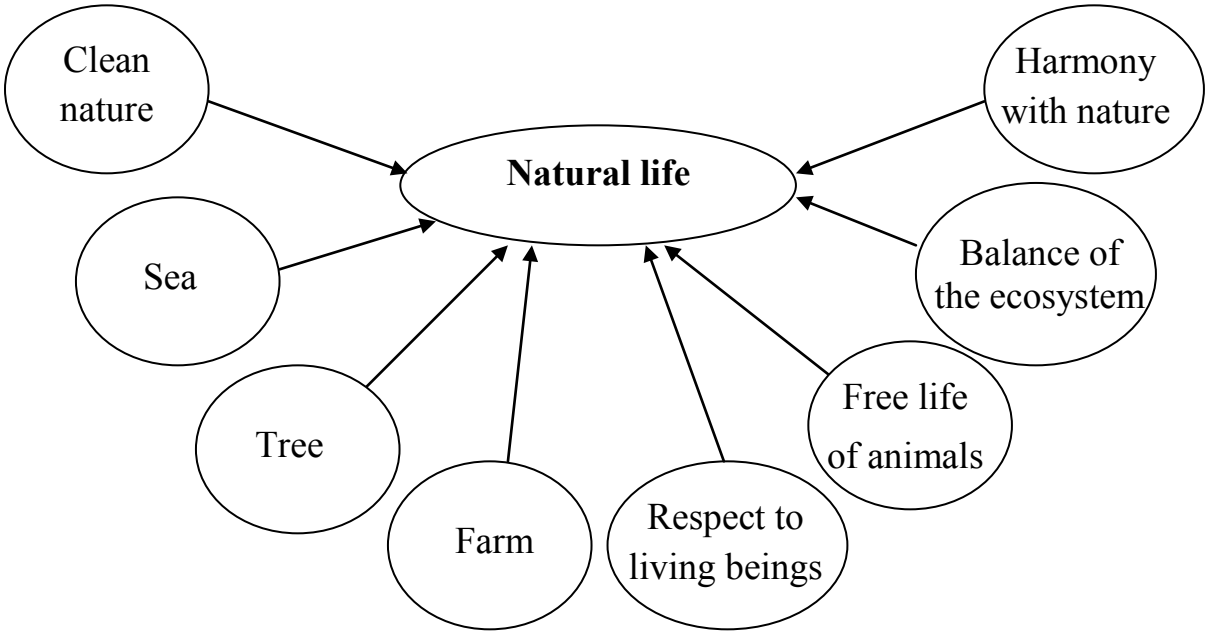
The responses of the pre-service teachers given to "In what kind of environment do you want to live? Please draw it" were classified under the categories presented in Table 1. As can be seen in Table 1, the pre-service teachers' responses given to this question before they participated in the nature education project are collected under five categories. Out of these categories, natural life and sustainable life categories came to the fore.

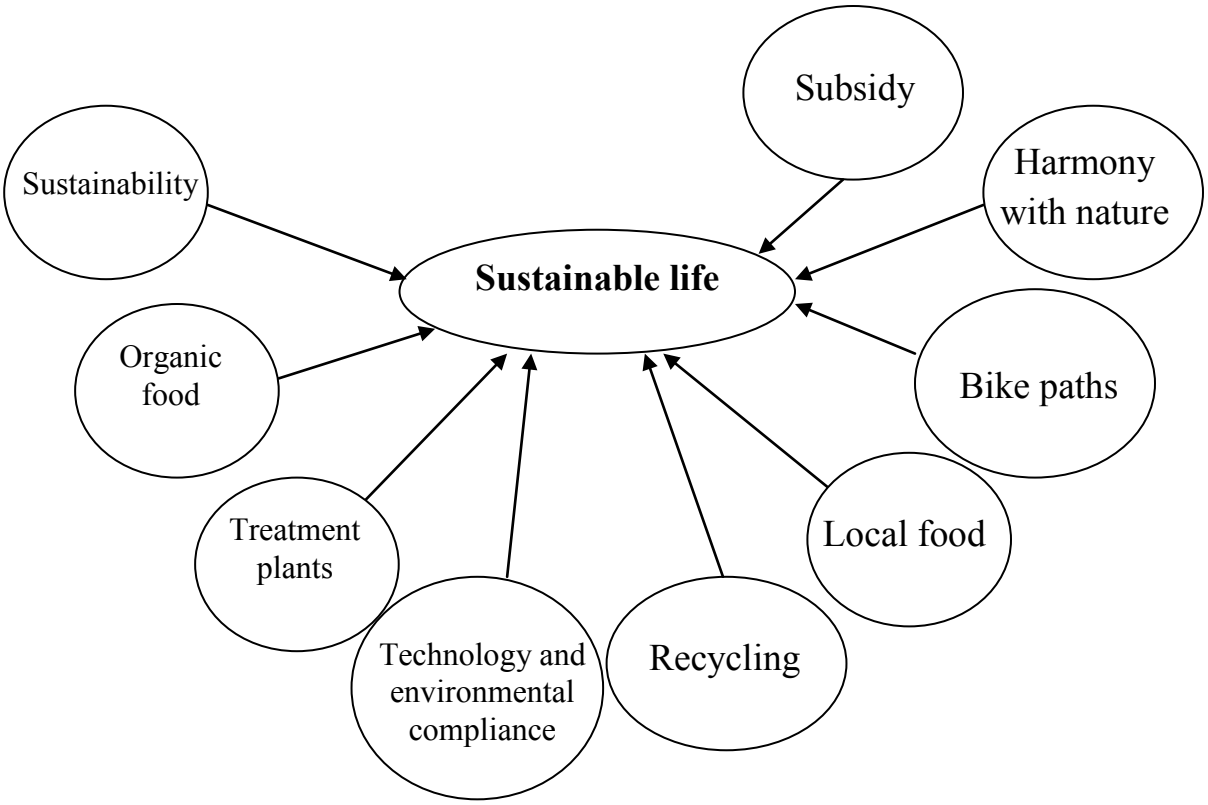
Table 1: The pre-service teachers' responses given to the question "In what kind of environment do you want to live? Please draw it."

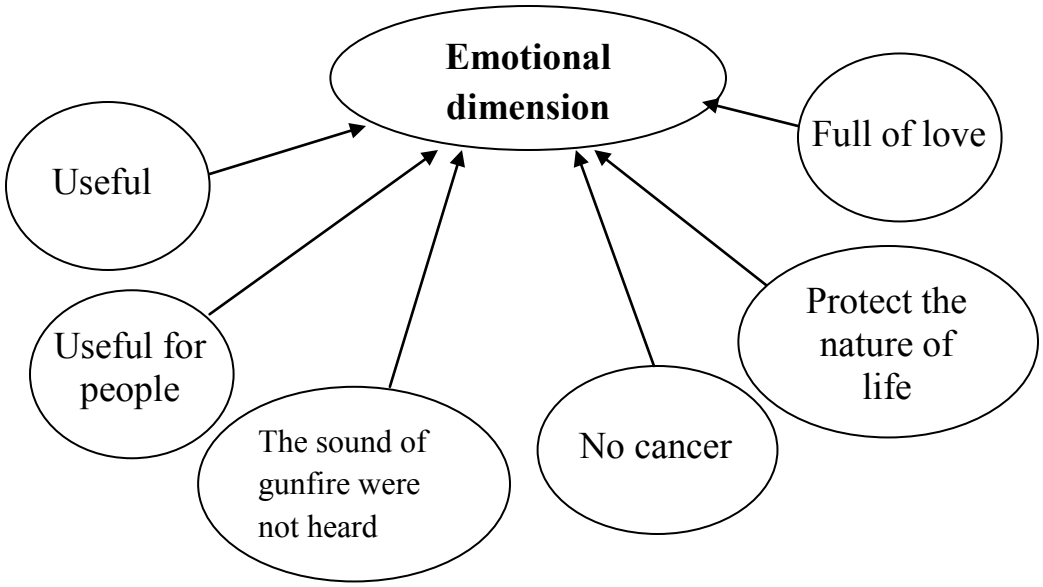
Categories	**f**	**%**
Natural life	25	42,37
Sustainable living	18	30,50
Emotional dimension	7	11,86
The use of renewable energy sources	5	8,47
Pollution	4	6,77

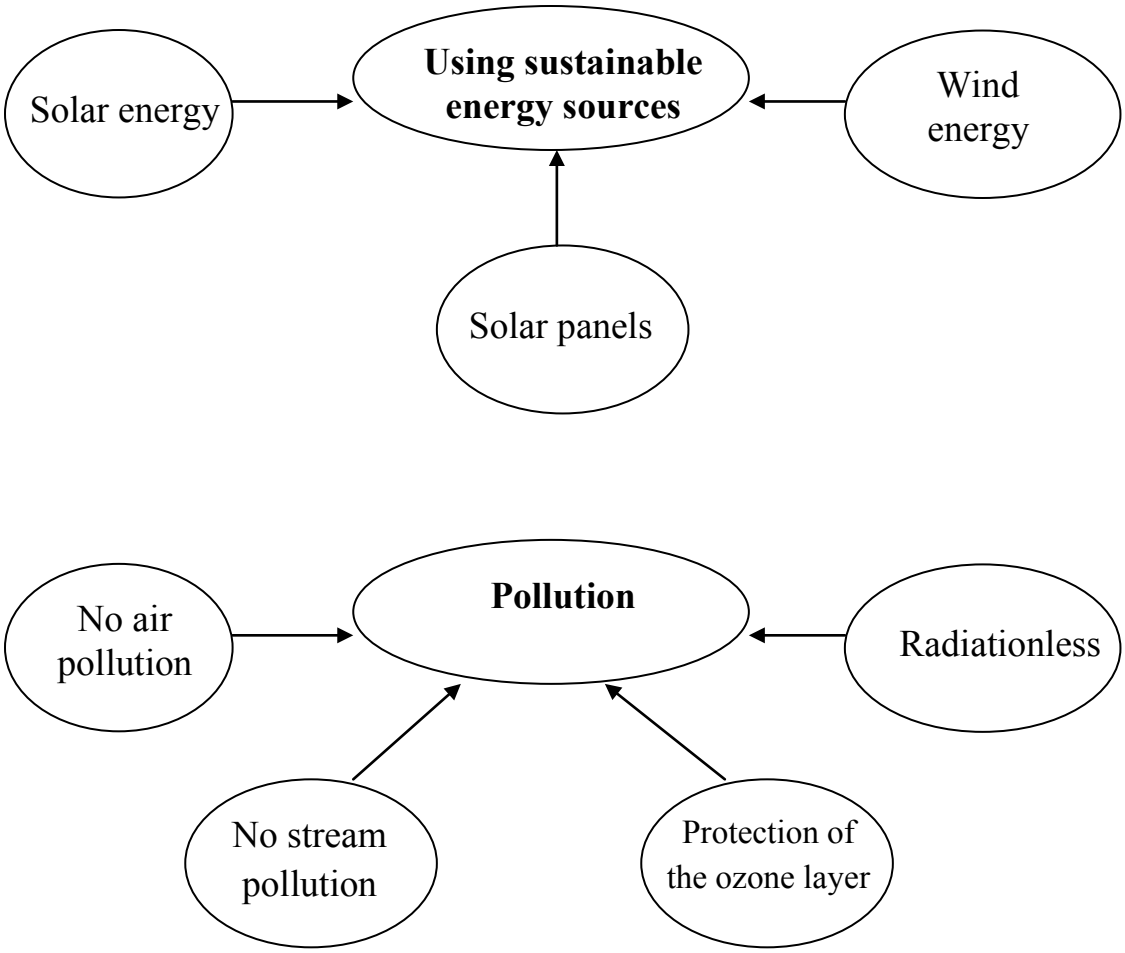
In figure 1, the concepts frequently mentioned by the pre-service teachers in each category are visualized.

Figure 1: Cognitive map of the responses of the pre-service teachers given to the question "In what kind of environment do you want to live? Please draw it."




Subsidy
Sustainability
Harmony with nature
Sustainable life
Organic food
Bike paths
Treatment plants
Local food
Technology and environmental compliance
Recycling


Emotional dimension
Useful
Full of love
Useful for people
Protect the nature of life
The sound of gunfire were not heard
No cancer



The pre-service teachers' responses given to the second question were separately investigated by the researchers and then put into certain categories. Then, tables of frequency showing how many times each concept was repeated by the students were constructed. Then, the conceptualizations of the researchers performed separately were brought together to subsume them under common categories. The data obtained in this way are presented in tables below:

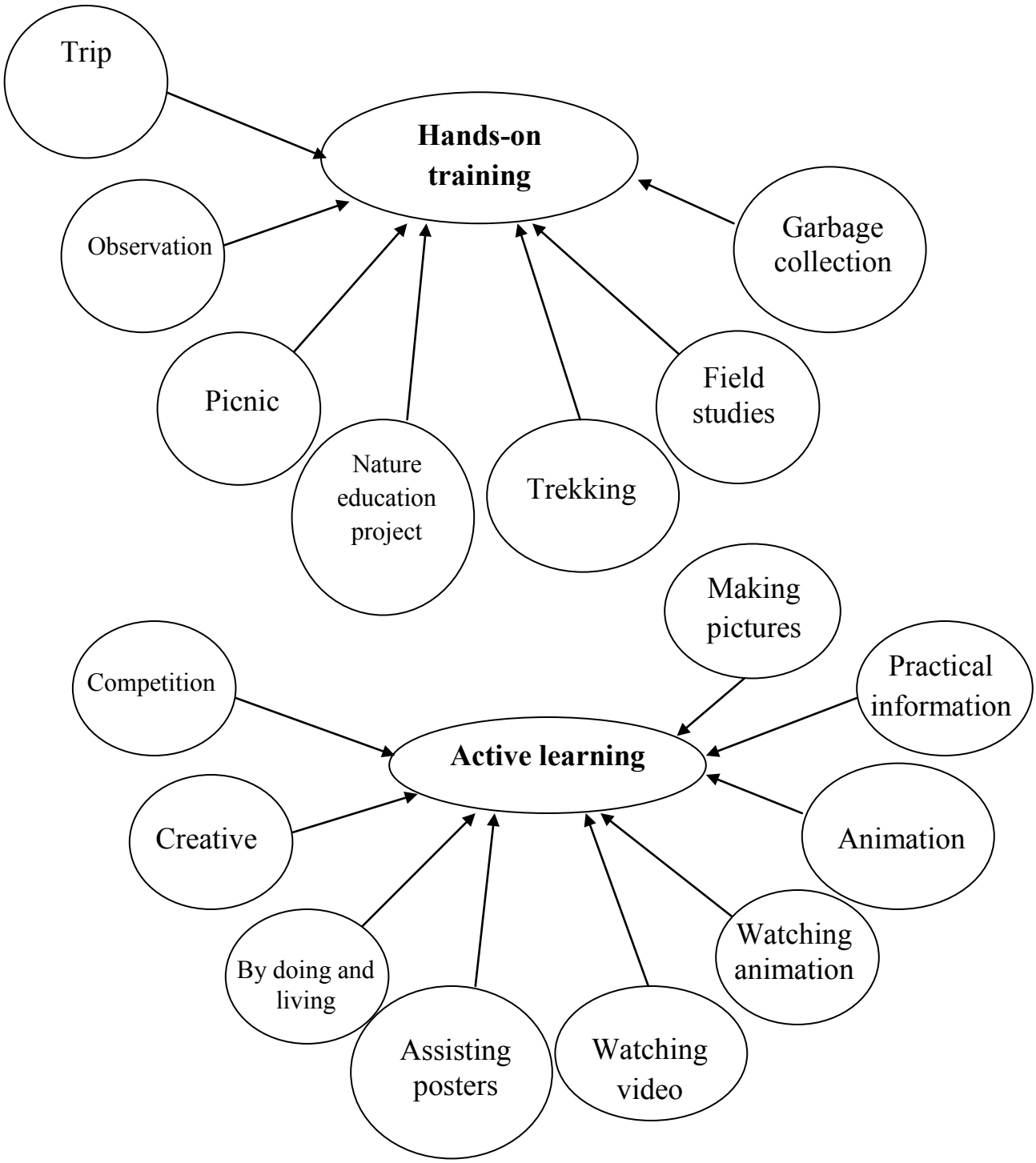
Table 2: The pre-service teachers' responses given to the question "What kind of environmental education do you want to give to your students? Please draw it."

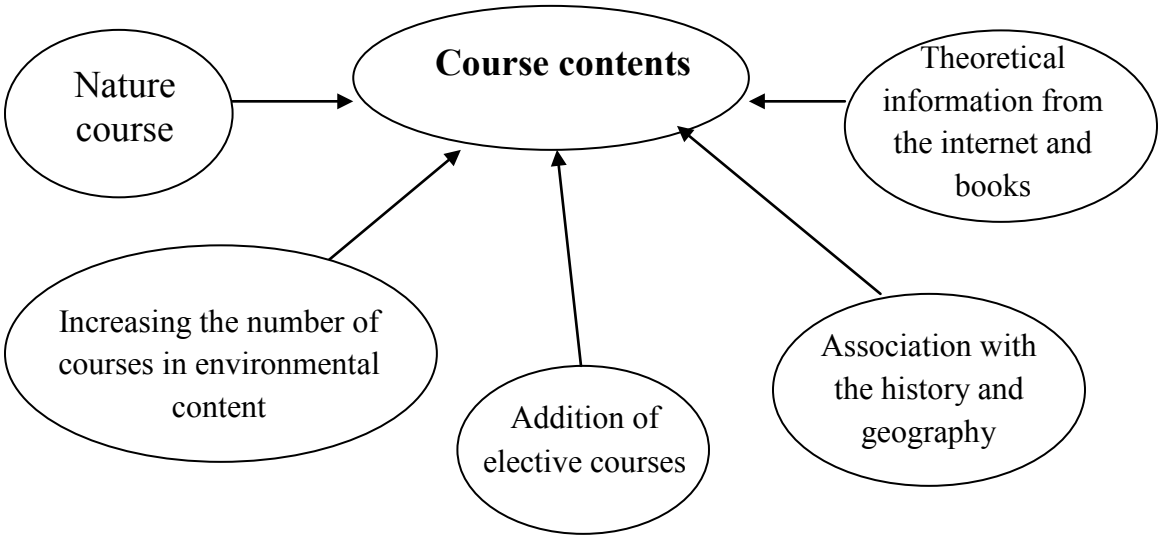
Categories	**f**	**%**
Active learning	21	35,59
Hands-on training	17	28,81
Parent training	7	11,86
Content of courses	7	11,86
Pre-school education	4	6,77
Public education	3	5,08

As can be seen in Table 2, the pre-service teachers' responses given to this question "What kind of environmental education do you want to give to your students? Please draw it." before they participated in the nature education project are collected under six categories. Out of these categories, active learning and hands-on training came to the fore.

The cognitive map of the pre-service teachers' responses to the question "What kind of environmental education do you want to give to your students? Please draw it." is presented in Table 2. And the categories presented in Table 2 are visualized in Figure 2. In these cognitive maps, the concepts mentioned by the pre-service teachers in relation to the categories are visualized.

Figure 2: Cognitive map of the pre-service teachers' responses to the question "What kind of environmental education do you want to give? Please draw it."





The Pre-service Teachers' Opinions about Environment and Environmental Education after Nature Education

Following the nature education, the pre-service teachers were asked to draw to respond the first question and then the opinions emphasized in these drawings were separately categorized. Then, the tables of frequency showing how many times each concept was repeated by the students were formed. Then, the conceptualizations of the researchers performed separately were brought together to subsume them under common categories. The data obtained in this way are presented in tables below.

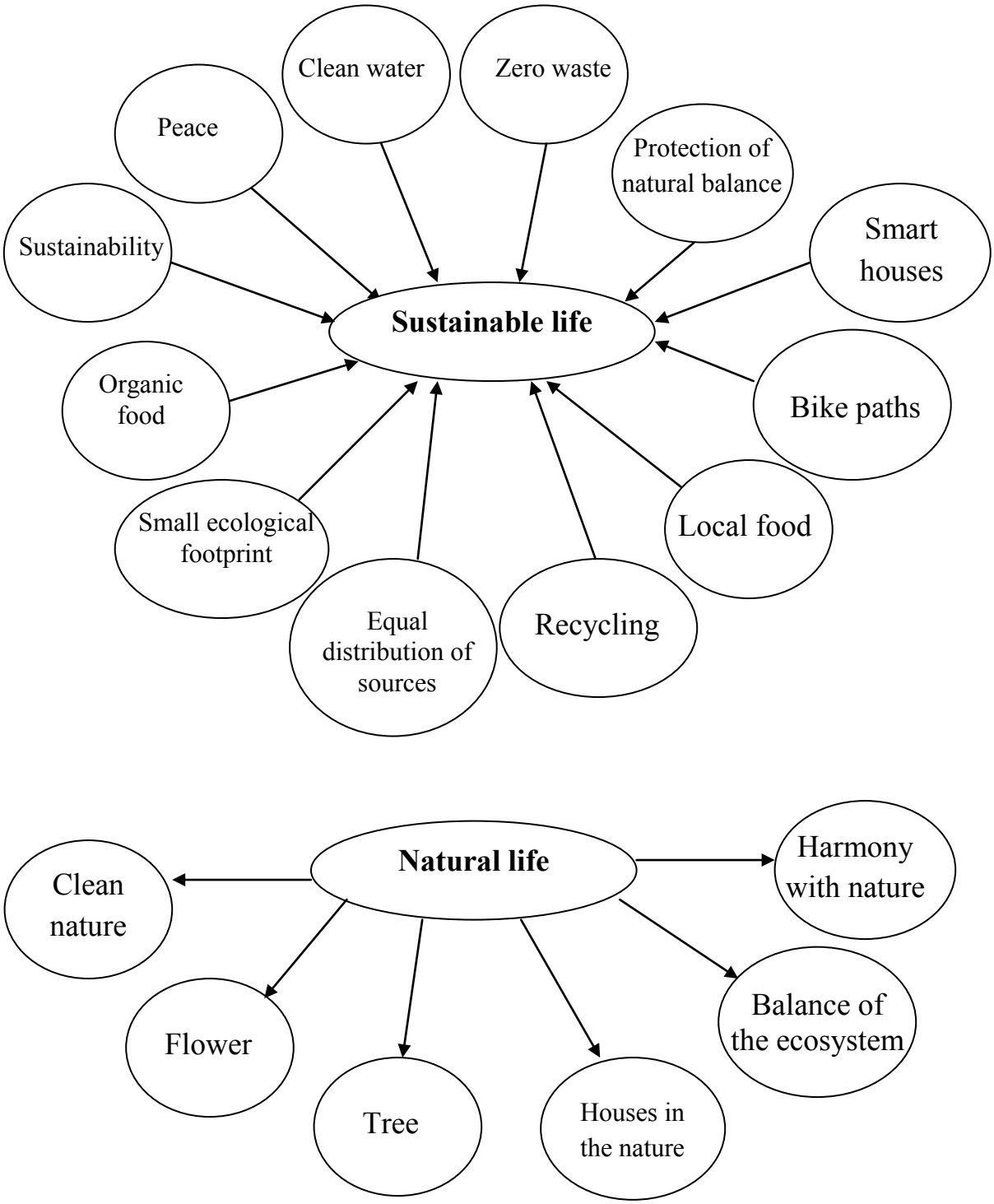
Table 3: The pre-service teachers' responses given to the question "In what kind of environment do you want to live? Please draw it."

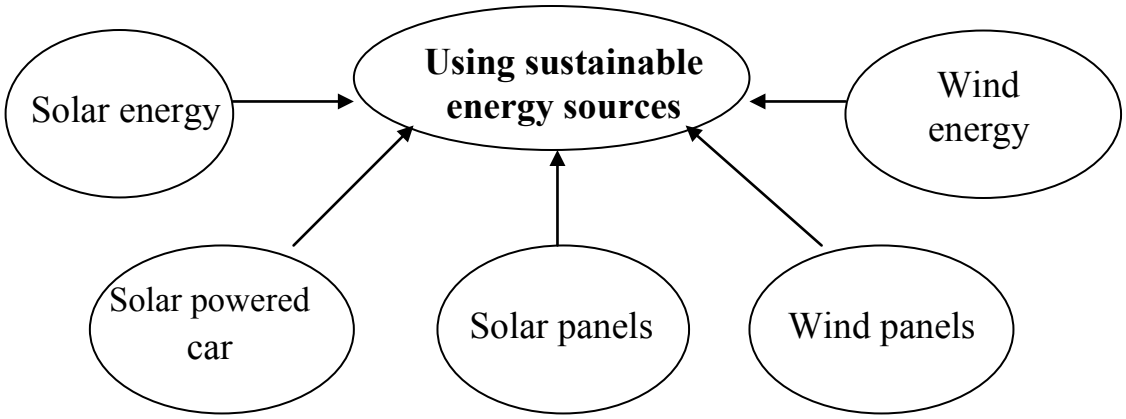
Categories	**f**	**%**
Sustainable living	28	45,16
Naturel life	20	32,25
The use of renewable energy sources	14	22,58

As can be seen in Table 3, the pre-service teachers' responses to the question "In what kind of environment do you want to live? Please draw it." after they participated in the project are collected under three categories. Out of these categories, sustainable life and natural life categories came to the fore. Pollution and affective categories emphasized by the pre-service teachers before they participated in the project were not mentioned after the project.

The pre-service teachers' responses to the question "In what kind of environment do you want to live? Please draw it." were collected under categories in Table 3 and they were visualized in Figure 3. The cognitive maps concerning the concepts expressed by the pre-service teachers under the categories of sustainable life, natural life and renewable energy are presented below.

Figure 3: The cognitive map of the pre-service teachers' responses to the question "In what kind of environment do you want to live? Please draw it"





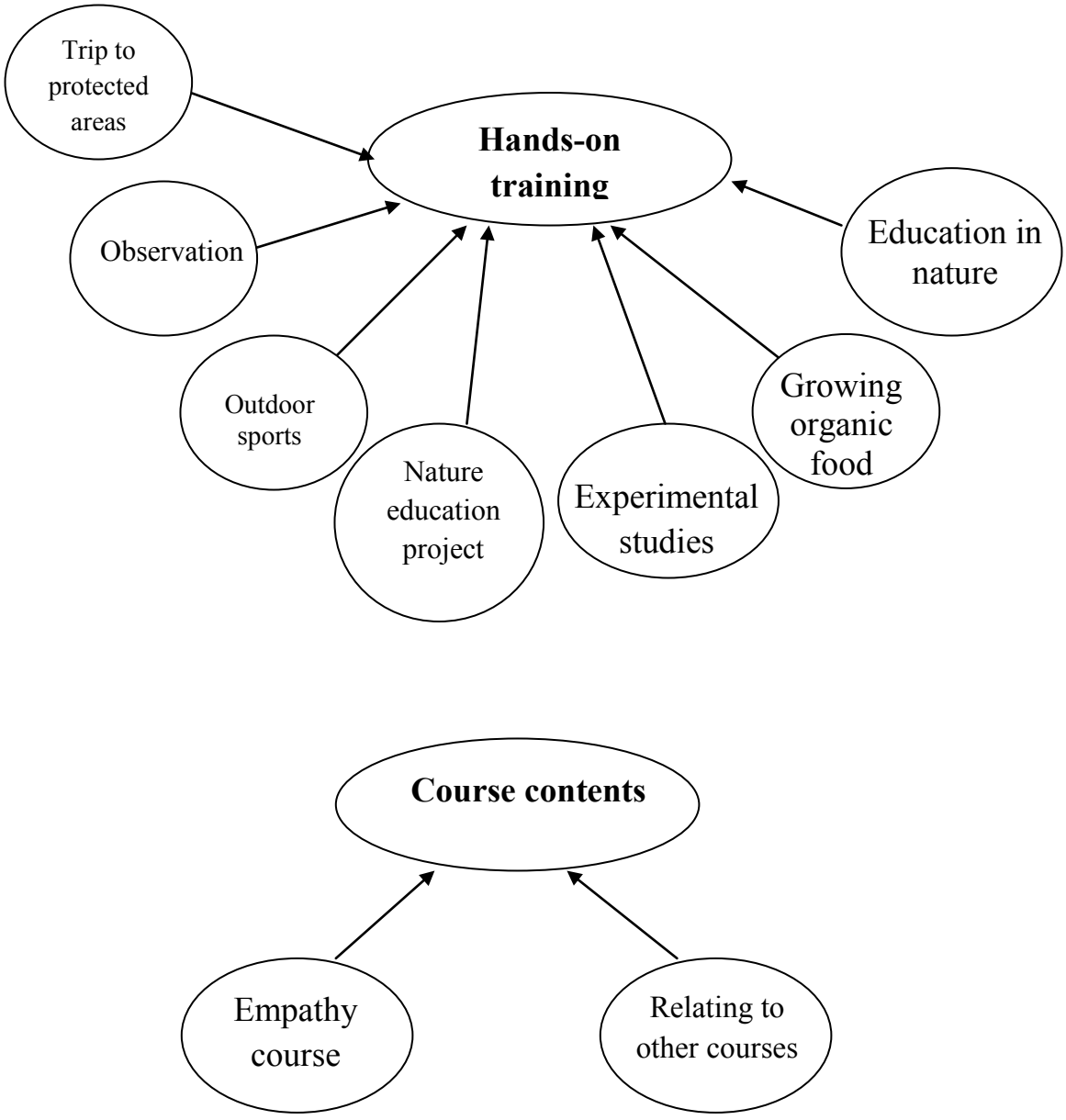
The pre-service teachers' responses to the second question were separately analyzed by the researchers and were put under certain categories. Then, the tables of frequency showing how many times each concept was repeated by the students were constructed. Then, the conceptualizations of the researchers performed separately were brought together to subsume them under common categories. The data obtained in this way are presented in tables below.

Table 4: The pre-service teachers' responses given to the question "What kind of environmental education do you want to give to your students? Please draw it".

Categories	f	%
Hands-on training	28	53,84
Active learning	18	34,61
Contents of courses	4	7,69
Parent training	1	1,92
Public education	1	1,92

As can be seen in Table 4, the pre-service teachers' responses to the question "What kind of environmental education do you want to give to your students? Please draw it." were collected under five categories. Out of these categories, applied education, active learning and course contents categories came to the fore. The pre-service teachers' responses to the question "What kind of environmental education do you want to give your students? Please draw it" were collected under categories in Table 4 and they were visualized in Figure 4. The concepts expressed in the related categories are presented in the following cognitive figures.

Figure 4: Cognitive map of the pre-service teachers' responses to the question "What kind of environmental education do you want to give to your students? Please draw it."



Discussion, Conclusions and Suggestions

It was found that the pre-service teachers' responses to the question "In what kind of environment do you want to live? Please draw it" concentrated on natural life and sustainable life concepts. Under the category of natural life; harmony with nature, balance of ecosystem, free living of animas, respect to living things, trees, seas and clean nature concepts were expressed. Under the category of sustainable life; sustainability, organic nutrients, purifying plants, harmony between technology and nature, recycling, local foods, cycling paths, harmony with nature and state subsidies concepts were expressed. Under the affective dimension, the pre-service teachers mentioned the concepts of utilization of renewable energy resources and pollution. Following the nature education; on the other hand, the pre-service teachers' responses to the same questions were collected under three categories called sustainable life, natural life and renewable energy resources. Different from what emerged prior to the application, under the category of sustainable life, peace, zero waste, small ecologic foot traces and equal distribution of resources were expressed. This shows that the participants' information about the basic principles of sustainable life enhanced after they participated in the study. Under the category of natural life; on the other hand, they mentioned the balance of ecosystem. However, while they mentioned the utilization of renewable energy resources before and after the application, they only focused on wind and solar energy.

It was observed in the pre-service teachers' responses to the question "What kind of environmental education do you want to give? Please draw it.", emphasis was put on the concepts such as active learning, hands-on training, parental education, course contents, pre-school education and public education. Under the category of active learning, the pre-service teachers mentioned organizing competitions, creative drama and learning by doing and experiencing. Under the category of applied education, they mentioned the concepts of field trips, observations, and environmental education projects. Under the category of course contents, they emphasized elective courses and increasing the number of courses with an environmental content. Following the nature education, they repeated the concepts such as applied education, active learning, course contents, parental education and public education. Different from the responses they gave before the study under the category of applied education, they mentioned the concepts of specially protected sites, nature sports, growing organic foods and experimental studies. Under the category of active learning, the concepts of student-centeredness, activity-based and alternative methods and techniques were emphasized. Under the category of course contents, they mentioned the concepts of the course of empathy and relating to other courses.

Following the nature education, the scope of the pre-service teachers' responses to these two questions was expanded. It was found that depending on the education given within the framework of the present study, the pre-service teachers' opinions improved. The concepts expressed by the pre-service teachers in their drawings show that the nature education has increased the participants' knowledge about environment. The findings of many studies carried out on environmental education support this finding. Findings of Benedict (1991) defining active learning as the key to achieving affective, ethical and behavioral objectives of environmental education and those of Ballantyne and Packer (2002) stating that interaction with nature is an effective strategy concur with the findings of the present study. Eaton (2000) stated that learning experiences occurring in open air are better than in-class learning experiences in terms of improving cognitive skills. Keleş, Uzun and Varnacı Uzun (2010) reported that nature education programs have significant influences on people's environmental consciousness, attitudes, and behaviors and enhance retention. Demirsoy emphasized the importance of field works by saying "*field works have resulted in many people becoming scholars. But we have not been able to explain this fact to anybody. We have not been able to make it widespread"* (Yanık, 2006).

In light of the findings of the present study, it is suggested that such projects supported by TÜBİTAK should be expanded and answers should be sought to the question "what type of environmental education should be given?".

Acknowledgements

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Continuous reaction crystallization of struvite from solution containing phosphate(V) and nitrate(V) ions

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Abstract: Research results concerning continuous removal of phosphates(V) using magnesium and ammonium ions from solutions containing 1.0 or 0.20 mass % of PO_4^{3-} ions and 0.0443 – 0.886 mass % of nitrate(V) ions are presented. Continuous struvite reaction crystallization process ran in stoichiometric conditions and at 20% excess of magnesium ions in DT MSMPR (*Draft Tube, Mixed Suspension Mixed Product Removal*) crystallizer with internal circulation of suspension in 298 K at pH 9 – 11 and mean residence time τ 900 – 3600 s. With the increase in nitrate(V) ions concentration in a feed solution mean crystal size L_m decreased by ca. 29%. Size-homogeneity within the crystal product population was not high. Increase in pH influenced product quality disadvantageously. Crystals of smaller sizes and lower homogeneity were manufactured. Elongation of mean residence time to 3600 s caused increase in crystals size even by 80% and improved size-homogeneity. Decrease of phosphate(V) ions concentration in a feed solution caused increase in mean size of struvite (by ca. 23%). Excess of magnesium ions influenced process results advantageously. Mean size of crystal products increased by more than 24%. Presence of nitrate(V) ions and process conditions in a crystallizer favored crystallization of struvite in a form of tubular crystals.

Key words: Struvite, phosphate(V) ions, nitrate(V) ions, continuous reaction crystallization, product quality, phosphorus recycling.

Introduction

Chemical removal of phosphate(V) ions from diluted aqueous solutions (e.g. from industrial, municipal wastewaters, or from liquid manure) is usually based on chemical binding of these ions in a form of sparingly soluble magnesium and ammonium salt, $MgNH_4PO_4 \cdot 6H_2O$, struvite, MAP (solubility product pK_{sp} = 9.0 – 13.26 (Doyle, 2002)). The reagents used in its precipitation process can be crystalline magnesium and ammonium compounds, their aqueous solutions, as well as wastewaters containing the required reagents in sufficiently high concentrations (Parsons, 2001). Providing optimal conditions for the controlled, continuous process of precipitation integrated with mass crystallization of sparingly soluble phosphate(V) salt(s) is a complex technological problem (Le Corre, 2009). Final result of this process – crystal population of determined chemical purity and size composition, produced with satisfactory yield – is dependent on many parameters precisely defining the environment in which these processes run, on these parameter values, as well as on the assumed constructional solutions (Doyle, 2002).

Struvite precipitates in ambient temperature from supersaturated water solutions of magnesium phosphate(V) in presence of ammonium ions within pH 7 – 11 range when molar ratio between the reagents $[PO_4^{3-}]_{RM} : [Mg^{2+}]_{RM} : [NH_4^+]_{RM} = 1 : 1 : 1$ is provided (Doyle, 2002). Both process course and its results are strongly influenced by pH, supersaturation, temperature, ionic strength of solution, presence of foreign substances, arrangement of crystallizer interior, mixing method and its intensity, circulation type, mean residence time of suspension in a crystallizer, spatial arrangement of reagent inlet places defining their contact method, etc. (Le Corre, 2007; Koralewska, 2009; Franke, 1995; Penicot, 1998). One of the fundamental control process parameters is pH of struvite reaction crystallization environment. The pH strongly influences struvite solubility and induction time (Bouropoulos, 2000). With the pH increase solubility of struvite decreases (its minimal value corresponds to pH 10.3 (Ohlinger, 1998) or 10.7

(Snoeyeink, 1980), while its precipitation potential increases (Doyle, 2002). Also induction time indispensable for nucleation process initiation shortens (Abbona, 1982). Other factor also strongly influencing the process course, thus the removed product quality, is presence of various impurities in phosphate(V) ions solutions. These are mainly metal ions, sulphates(VI), nitrates(V), fluorides and fluosilicates. These inhibit or catalyze the precipitation reaction course, influence nucleation and crystal phase growth kinetics, modify crystal shape and eventual promote some agglomeration effects (Le Corre, 2005; Hutnik, 2011a; Hutnik, 2011b). Some of metal ions in alkaline environment of struvite continuous reaction crystallization process can also form sparingly soluble hydroxides or phosphates, what essentially deteriorates chemical composition of the product and limits the possibilities of its further applications (de–Bashan, 2004).

One of the impurities frequently identified in industrial wastewaters are nitrate(V) ions. The experimental research results focusing on the influence of nitrate(V) ions concentration on the results of struvite $MgNH_4PO_4 \cdot 6H_2O$ reaction crystallization process in a continuous laboratory DT MSMPR (*Draft Tube, Mixed Suspension Mixed Product Removal*) type crystallizer with propeller are presented. Process yield, defined as a final concentration of PO_4^{3-} ions in mother solution, was calculated. Product crystals size distributions and their statistical parameters (L_m, L_{50}, L_d, CV) were identified. Crystal shapes (L_a/L_b) and their agglomeration were also determined.

Materials and Methods

Scheme of laboratory stand for the tests of struvite continuous reaction crystallization process in presence of nitrate(V) ions is presented in Figure 1. Steering, control and acquisition of measurement data were done with the use of computer. For precise control of measuring system working in a steady state conditions the IKA labworldsoft program was used. Working volume of the crystallizer was 0.6 dm^3. The crystallizer used was a glass cylindrical tank (D 120 mm, H 123 mm), in a bottom part equipped with heating/cooling jacket (thermostated with external water circulation system), providing stabilization of the process temperature. In a central axis of apparatus cylindrical circulation tube (*Draft Tube*, DT, d_{dt} 57 mm, h_{dt} 53 mm) was placed, inside which three-paddle propeller (d_m 55 mm) operated. Inlet ports of reagents and alkalizing solution, as well as product crystal suspension removal port are marked in Figure 1. The crystallizer was continuously fed with solution prepared previously in a mixer from chemically pure substances (crystalline magnesium chloride hexahydrate $MgCl_2 \cdot 6H_2O$, ammonium dihydrogenphosphate(V) $NH_4H_2PO_4$ and sodium nitrate(V) $NaNO_3$ – POCh Gliwice, Poland) and deionized water (Barnstead – NANOpure DIamond). This solution was introduced into the circulation profile interior (stirrer speed: 6.6 ±0.1 1/s; suspension movement – downward). Between the crystallizer body and circulation pipe (suspension movement – upward) aqueous solution of sodium hydroxide of concentration 20 mass % of NaOH was dosed in proportion providing the assumed, controlled pH value of struvite continuous reaction crystallization environment.

Temperature in a crystallizer was 298 ±0.2 K. The research tests were done in stoichiometric conditions (molar proportions of reagent ions in a feed $[PO_4^{3-}]_{RM} : [Mg^{2+}]_{RM} : [NH_4^+]_{RM} = 1 : 1 : 1$) and at 20% excess of magnesium ions ($[PO_4^{3-}]_{RM} : [Mg^{2+}]_{RM} : [NH_4^+]_{RM} = 1 : 1.2 : 1$). Concentration of phosphate(V) ions in a crystallizer feed was 1.0 or 0.20 mass %, magnesium ions: 0.256 or 0.0512 mass % – in stoichiometric conditions and 0.307 or 0.061 mass % – at their 20% excess, and ammonium ions: 0.190 or 0.0380 mass %, respectively. Concentration of nitrate(V) ions varied from 0.0443 to 0.886 mass % depending on studied case. Continuous reaction crystallization of struvite ran at pH 9 (±0.1) and for mean residence time of suspension in a crystallizer τ 900 s (±20 s). For nitrate(V) ions concentration in a feed $[NO_3^-]_{RM}$ 0.0886 mass % also tests for pH 10 and 11, as well as for τ 1800 and 3600 s were also done.

After stabilisation of the assumed process parameter values in a crystallizer, continuous process in a steady state ran through the next 5τ. After this time whole crystallizer content was transferred onto vacuum filter. After mother solution drainage, the crystals were not washed. Crystal phase was weighed before and after drying. Also weight and volume of mother solution were determined. This way concentration of solid phase in product crystals suspension was calculated (M_T). Crystal size distribution was determined with the use of solid particle analyzer COULTER LS–230, whereas crystal shape – from individual planimetric measurements based on crystal population images from scanning electron microscope JEOL JSM 5800LV. Chemical composition of mother solution and crystal phase were identified using, among others, plasma emission spectrometer ICP–AES CPU 7000, spectrometer IR PU9712 and spectrophotometer UV–VIS Evolution 300. Accuracy of the measurement data concerning continuous

struvite reaction crystallization process in a laboratory plant was estimated to be ca. 10%.

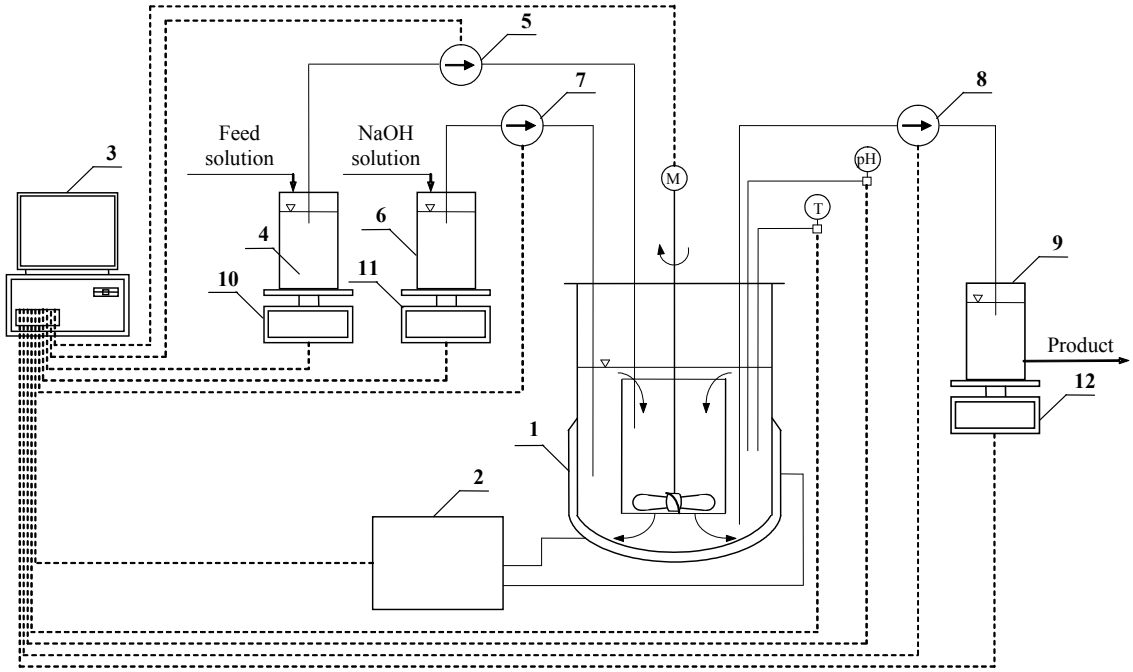

Figure 1: Laboratory test stand scheme of continuous crystallizer with propeller mixer for reaction crystallization of struvite, 1 – DT type crystallizer with internal circulation of suspension, 2 – thermostat, 3 – computer, 4 – reservoir of feed mixture: aqueous solution of $NH_4H_2PO_4$, $MgCl_2$ and $NaNO_3$, 5 – feed proportioner (pump), 6 – alkalinity agent tank: aqueous solution of NaOH, 7 – proportioner of NaOH solution, 8 – receiver (pump) of a product crystal suspension from the crystallizer tank, 9 – storage tank of product crystal suspension, 10, 11, 12 – electronic balances, M – stirrer speed control/adjustment, pH – alkaline/acid reaction control/adjustment, T – temperature control/adjustment.

Results and Discussion

The research tests and analyses results are presented in Table 1. From these data it results, that presence of nitrate(V) ions influences both size of product struvite crystals and their size–homogeneity disadvantageously (tests No. 1 – 5 in Table 1). With the increase in NO_3^- ions concentration in a feed from 0.0443 to 0.886 mass % mean crystal size L_m decreased from 31.0 to 21.9 μm (thus by ca. 29%), similar to median crystal size L_{50} 24.0 → 16.4 μm (Hutnik, 2009). Size homogeneity of product crystal population was not satisfactory. Coefficient of crystal size homogeneity CV varied within the 84.0 – 99.2% range (average 91.4%).

Decrease of mean size L_m of product crystals with the increase in nitrate(V) ions concentration in a process system is connected with general increase in the number of the smallest struvite crystals in the whole product population. In result dominant crystal size shifts towards smaller values: L_d 30.6 → 19.5 μm for $[NO_3^-]_{RM}$ 0.0443 → 0.886 mass %, while number and size of the largest crystals in a product decrease. The largest size of struvite crystals produced in the presence of 0.0443 mass % of nitrate(V) ions is 170 μm, while in the presence of 0,886 mass % NO_3^- – only ca. 140 μm. Simultaneously the smallest size fraction enlarges. For $[NO_3^-]_{RM}$ 0.0443 mass % crystal fraction of sizes below 5 μm in a product was 10.2%, while in case of $[NO_3^-]_{RM}$ 0.886 mass % this fraction increased up to 19.2%, thus by ca. 90%. This trend is clearly visible in Figure 2, presenting exemplary volumetric (mass) product crystal size distributions (solid particle laser analyzer COULTER LS–230) self-established in the presence of 0.0886

and 0.443 mass % of nitrate(V) ions in a feed (pH 9, τ 900 s).

Table 1: Experimental test results concerning continuous struvite reaction crystallization process in a DT MSMPR crystallizer. Reaction crystallization process temperature: 298 K.

No.	Process parameters				Suspension in crystallizer		Crystal product characteristic*)				
	$[PO_4^{3-}]_{RM}$	$[NO_3^-]_{RM}$	pH	τ	M_T	$[PO_4^{3-}]_{ML}$	L_m	L_{50}	L_d	CV	L_a/L_b
	mass %	mass %	–	s	kg crystals/m^3	mg/kg	μm	μm	μm	%	–
Molar proportions of reagent ions in a feed: $[PO_4^{3-}]_{RM} : [Mg^{2+}]_{RM} : [NH_4^+]_{RM} = 1 : 1 : 1$											
1	1.0	0.0443	9	900	24.3	163	31.0	24.0	30.6	88.8	6.6
2	1.0	0.0886	9	900	24.2	147	29.4	20.3	27.6	88.5	6.6
3	1.0	0.221	9	900	24.0	148	28.7	19.2	23.0	96.6	6.6
4	1.0	0.443	9	900	24.0	150	27.9	18.0	23.8	99.2	7.6
5	1.0	0.886	9	900	24.1	145	21.9	16.4	19.5	84.0	7.8
6	1.0	0.0886	10	900	24.3	130	24.6	17.1	23.2	94.4	7.8
7	1.0	0.0886	11	900	24.7	122	17.8	12.4	10.5	96.8	8.2
8	1.0	0.0886	9	1800	24.6	141	32.9	26.3	29.3	83.1	6.8
9	1.0	0.0886	9	3600	24.9	134	52.7	40.7	54.4	86.1	7.2
10	0.20	0.0886	9	900	4.7	147	36.2	25.0	31.1	95.9	6.8
11	0.20	0.443	9	900	4.7	152	36.0	23.4	30.8	93.4	7.6
Molar proportions of reagent ions in a feed: $[PO_4^{3-}]_{RM} : [Mg^{2+}]_{RM} : [NH_4^+]_{RM} = 1 : 1.2 : 1$											
12	1.0	0.0886	9	900	24.6	23	36.6	26.9	31.6	95.6	6.7
13	1.0	0.443	9	900	24.7	22	35.0	26.0	31.1	95.2	7.8
14	0.20	0.0886	9	900	4.8	27	41.1	30.0	36.2	92.6	6.8
15	0.20	0.443	9	900	5.0	32	39.0	28.4	35.6	93.4	7.8

*) Without product crystal washing

$L_m = \Sigma x_i L_i$, where: x_i – mass fraction of crystals of mean fraction size L_i; L_{50} – median crystal size for 50 mass % undersize fraction; L_d – crystal mode size; $CV = 100(L_{84} - L_{16})/(2L_{50})$, where: L_{84}, L_{16}, L_{50} – crystal sizes corresponding to 84, 16 and 50 mass % undersize fractions.

In Figure 3 there are presented scanning electron microscope images of product crystal samples, which size distributions are shown in Figure 2. Differences in size and shape within the struvite crystals (L_m 29.4 and 27.9 μm, appropriately) are clearly visible. From these exemplary product images one can also conclude about lower than moderate agglomeration effects within large struvite crystals.

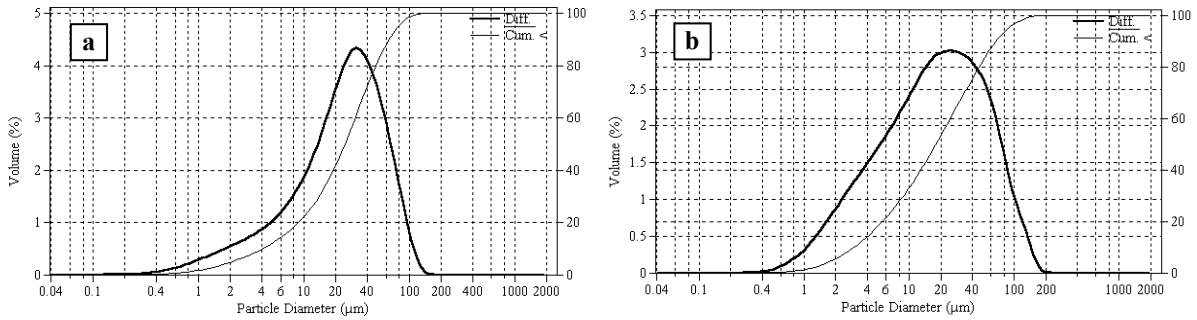

Figure 2: Exemplary differential (left scale) and cumulative (right scale) volumetric (mass) size distributions of

crystals produced in continuous struvite reaction crystallization process in presence of 0.0886 mass % (a) and 0.443 mass % (b) nitrate(V) ions in a feed (pH 9, τ 900 s, corresponding to No. 2 and 4 in Table 1).

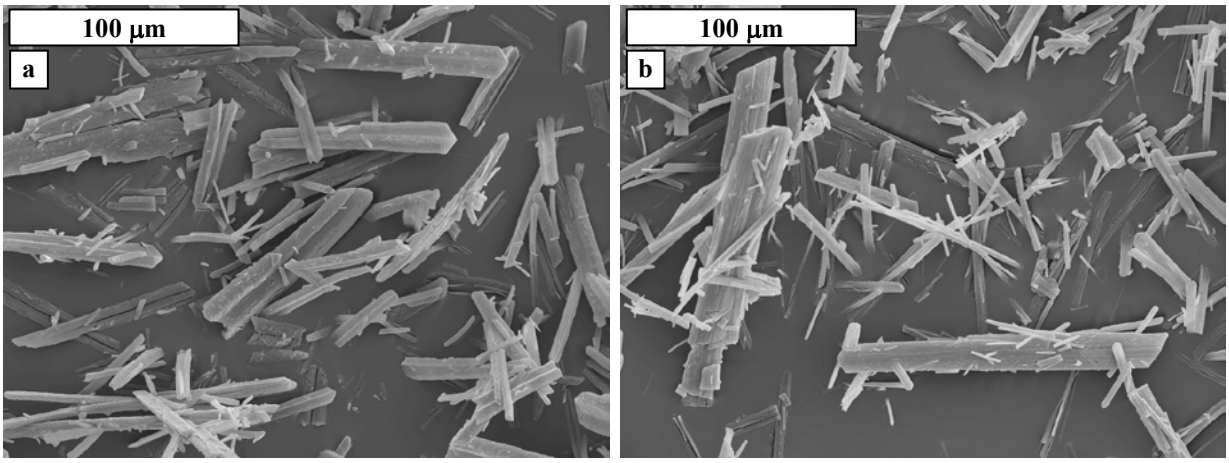

Figure 3: Scanning electron microscope images of struvite crystals produced in a continuous DT MSMPR crystallizer in presence of 0.0886 mass % (a) and 0.443 mass % (b) nitrate(V) ions in a feed (corresponding to Figure 2 cases). Magnification: 500×.

With the increase in pH of struvite continuous reaction crystallization process environment product crystal size decreased, as well (tests No. 2, 6 and 7 in Table 1). Raise of pH from 9 to 11 (τ 900 s) caused, that mean crystal size L_m decreased by ca. 40%: from 29.4 to 17.8 μm at concentration 0.0886 mass % nitrate(V) ions in a feed. Increase in crystallizer environment's pH did not favour homogeneity of the manufactured product. The CV coefficient increased up to 96.8%. Dominant crystal size L_d shifted towards smaller values: from 27.6 μm (pH 9) to 10.5 μm (pH 11). In a crystalline product both number and size of the largest struvite crystals decreased. Their largest size at pH 9 was ca. 160 μm (Figure 2a), while at pH 11 – only 80 μm (Figure 4a). Simultaneously fraction of the smallest size particles enlarged. At pH 9 crystal fraction of sizes below 5 μm in a product was 12.1%, while at pH 11 it raised up to 18.9%. In result crystal mean size L_m decreased significantly from 29.4 to 17.8 μm. In Figure 5a there is presented scanning electron microscope image of product crystals, which size distribution is shown in Figure 4a. Smaller sizes of struvite crystals produced at pH 11 are clearly observable (compare Figures 3a and 5a).

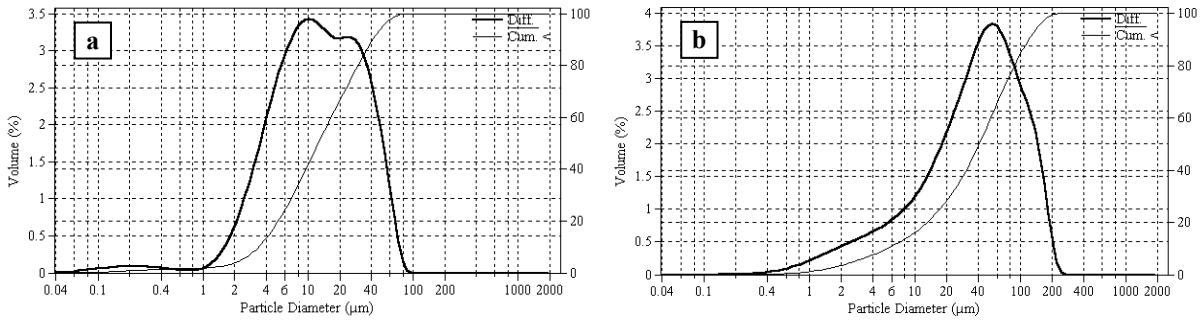

Figure 4: Exemplary differential (left scale) and cumulative (right scale) volumetric (mass) size distributions of crystals produced in a continuous reaction crystallization process in presence of 0.0886 mass % of nitrate(V) ions in a feed: a) pH 11, τ 900 s and b) pH 9, τ 3600 s (corresponding to No. 7 and 9 in Table 1).

Elongation of mean residence time of suspension in a crystallizer up to 3600 s caused, however, increase in product crystal size even by ca. 80% (tests No. 2, 8 and 9 in Table 1). In presence of 0.0886 mass % nitrate(V) ions struvite crystals reached mean size L_m 52.7 μm (pH 9, τ 3600 s). Elongation of mean residence time produces decrease

of solution supersaturation, thus decrease of process kinetic component values: nucleation rate of struvite crystals, as well as their linear growth rate.

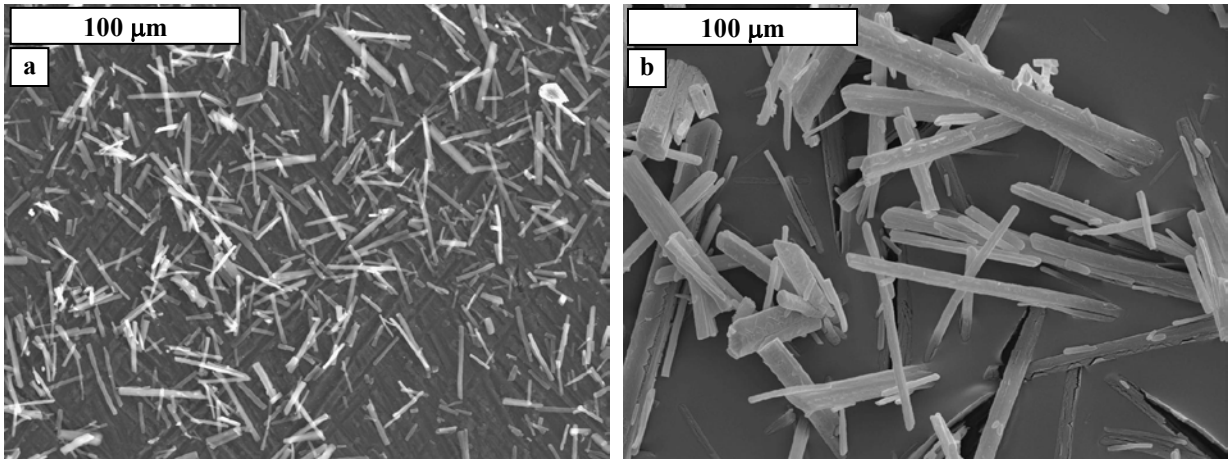

Figure 5: Scanning electron microscope images of struvite crystals produced in a continuous DT MSMPR crystallizer in the presence of 0.0886 mass % of nitrate(V) ions in a feed. Process parameters: a) pH 11, τ 900 s, b) pH 9, τ 3600 s (corresponding to Figure 4 cases). Magnification: 500×.

Longer residence time of crystals in the supersaturated mother solution made, however, that final effect of the process was advantageous. Crystal phase grew slower, however more stable and longer, thus reached larger final sizes. Their population homogeneity (CV 86.1%) improved. Elongation of mean residence time up to 3600 s made that dominant size L_d of struvite crystals shifted towards higher values: from 27.6 μm (τ 900 s) to 54.4 μm (τ 3600 s). Size of the largest crystals in a whole product crystal population reached 160 μm (τ 900 s, Figure 2a) and 250 μm (τ 3600 s, Figure 4b). Fraction of the smallest-size crystal decreased visibly. Crystal population of size $L < 5$ μm in a product represented 12.1 and 9.2%, respectively. Electron microscope image of crystals produced at τ 3600 s is presented in Figure 5b. The number of small size crystals also decreased. In a microscope's „field of vision" one can notice original in shape tubular crystals. Struvite crystals are damaged. One can notice slightly deformed edges and surface defects.

Simultaneous influence of nitrate(V) ions concentration in a crystallizer feed ($0.0443 \le [NO_3^-]_{RM} \le 0.886$ mass %), pH of process environment ($9 \le pH \le 11$) and mean residence time of suspension in a working volume of the crystallizer ($900 \le \tau \le 3600$ s) on mean product crystals size L_m (in μm) can be presented in a form of empirical correlation, Eq. (1):

$$L_m = 5.374 \cdot 10^2 \, [NO_3^-]_{RM}^{-0.098} \, pH^{-2.665} \, \tau^{0.400} \quad (1)$$

with correlation coefficient R^2 0.941 and mean relative error ±8.6%. Correlation (1) is based on 11 sets of experimental data (Table 1).

The 5-time decrease of phosphate(V) ions concentration in a feed (from 1.0 to 0.20 mass %) produces increase in struvite mean crystal size L_m by 23% (tests No. 2, 4, 10 and 11 in Table 1). Local supersaturation at the crystallizer inlet decreased. Thus struvite nucleation rate, very strongly dependent on supersaturation, decreased as well. It caused decrease of nuclei number, producing thus larger mean size of the crystals removed from the crystallizer.

Excess of magnesium ions in relation to phosphate(V) and ammonium ions content in a crystallizer feed (molar proportions $[PO_4^{3-}]_{RM} : [Mg^{2+}]_{RM} : [NH_4^+]_{RM} = 1 : 1.2 : 1$) influenced the process results advantageously (tests No. 12 – 15 in Table 1). Mean struvite crystal size L_m enlarged from 36.2 to 41.1 μm (by 13%) and from 36.0 to 39.0 μm (by 8%) for $[PO_4^{3-}]_{RM}$ 0.20 mass % in presence of nitrate(V) ions of concentration 0.0886 and 0.443 mass %, respectively. Higher supersaturation in respect to magnesium ions in a discussed process environment generally influenced all partial phenomena creating complex reaction crystallization process advantageously. Net effect (among others higher nucleation rate, however also higher crystal growth rate) caused more favourable product crystal size distribution.

From the analysis of scanning electron microscope images of crystal products (Figures 3 and 5) it results, that

struvite crystals habit was not identical. Based on planimetric measurement results covering 50 crystals randomly selected from three scanning electron microscope images (from each product crystals population) it was concluded, that mean ratio of their length L_a to their width L_b varied from 6.6 to 8.4 depending on the process parameter values (Table 1). Increase in nitrate(V) ions concentration in a feed caused that geometrical simplex L_a/L_b varied from 6.6 to 7.8. The crystals became shorter and thinner (Figure 3). Increase in process environment's pH resulted that crystal length L_a and width L_b decreased, however width L_b decreased more: L_a/L_b = 6.6, 7.8 and 8.2 – appropriately for pH 9, 10 and 11 (τ 900 s and $[NO_3^-]_{RM}$ 0.0886 mass %, Figures 3a and 5a). With the elongation of mean residence time of suspension in a crystallizer both crystal length L_a and their width L_b enlarged, however not in a proportional way. The L_a/L_b simplex value enlarged from 6.6 to 7.2 (Figures 3a and 5b). Lower concentration of phosphate(V) ions in a feed and magnesium ions excess in a process system did not introduce essential changes in mean values of L_a/L_b.

In Table 1 there are also presented analytically determined concentrations of phosphate(V) ions in a postprocessed mother solution. It may be practically assumed, that this concentration stabilised on a relatively constant and low level 144 ±20 mg PO_4^{3-}/kg in stoichiometric conditions and 26 ±5 mg PO_4^{3-}/kg in the presence of magnesium ions excess. Average efficiency of phosphate(V) ions removal from a feed solution ranged thus from 92 to 99% depending on process technological parameters. Presence of nitrate(V) ions in a continuous struvite reaction crystallization system does not influence essentially the residual level of phosphate(V) ions concentration in a postprocessed mother solution. These concentration values, however, decreased systematically with the pH increase and with elongation of mean residence time of struvite crystals suspension in a crystallizer. It can be explained by decrease of struvite solubility with the increase in reactive mixture pH, while longer contact time of crystal phase with supersaturated solution in a crystallizer provides more thorough discharge of the generated supersaturation. Working supersaturation in a crystallizer, thus in a postprocessed mother solution can not be, however, calculated with satisfactory high precision. In majority of published works solubility product of struvite pK_{sp} 13.26 (Ohlinger, 1998) is assumed, where corresponding equilibrium concentration of phosphate(V) ions is 3.6 mg/kg. In reality this value is unknown, since it depends on many process, technological and even constructional factors, and differs significantly from the value provided by Ohlinger at al. (1998). Excess of magnesium ions with reference to phosphate(V) and ammonium ions concentrations influenced thus the process yield advantageously. Concentration of phosphate(V) ions in a postprocessed mother solution was distinctly smaller (from 5- to 7-time) than in stoichiometric conditions technological case.

Conclusions

The research results concerning continuous removal of phosphate(V) ions from the diluted aqueous solutions ($[PO_4^{3-}]_{RM}$ 0.20 and 1.0 mass %) with the use of magnesium and ammonium ions in the presence of nitrate(V) ions are shown. The research was carried out in a DT MSMPR type crystallizer with internal circulation of suspension driven by propeller mixer both in stoichiometric conditions and at 20% excess of magnesium ions with relation to phosphate(V) and ammonium ions contents. It was concluded, that with the increase in feed concentration of nitrate(V) ions from 0.0443 to 0.886 mass %, mean size of crystal product L_m decreased by ca. 29% (from 31.0 to 21.9 μm at pH 9 and τ 900 s, $[PO_4^{3-}]_{RM}$ 1.0 mass %). Homogeneity within the product crystals population was not high (average CV ca. 91%). Increase in pH of continuous struvite reaction crystallization process environment influenced crystalline product quality disadvantageously. Crystals of smaller sizes (L_m 17.8 μm at pH 11, τ 900 s and feed concentration of nitrate(V) ions 0.0886 mass %) and of lower homogeneity (CV ca. 97%) were produced. Contrary, elongation of mean residence time of suspension in a crystallizer (up to 3600 s, pH 9), responsible however for decrease of working supersaturation in mother solution, caused enlargement of product crystals size even by 80% (L_m ca. 53 μm). Homogeneity within crystal population improved (CV ca. 86%). In process conditions characterized by relatively long mean residence time of suspension in a crystallizer higher quality product is formed. However, under these process conditions unit process yield is small, thus lower economical efficiency of a whole production plant is reported.

Based on product crystal images (scanning electron microscope) it was concluded, that crystal agglomeration effects were less than moderate. Properly shaped struvite crystals were produced. Presence of nitrate(V) ions in the reaction crystallization system and process conditions established in a crystallizer favoured struvite crystallization in a characteristic form of tubular crystals.

Decrease of phosphate(V) ions concentration in a feed (to 0.20 mass % of PO_4^{3-}) caused increase in mean size of struvite crystals (by ca. 23%). Similarly, excess of magnesium ions in relation to phosphate(V) and ammonium ions content in this solution influenced the process results advantageously. Mean size of product crystals enlarged by more than 24%.

Excess of magnesium ions in a process system definitely influenced the continuous struvite reaction crystallization process yield advantageously. Concentration of phosphate(V) ions in a postprocessed mother solution decreased to 22 – 32 mg/kg depending on the feed composition, what can be regarded as a very good result of their removal from solution.

Acknowledgements

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De-inking paper sludge requirement of liming high acidic potato soil

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Abstract: Biosolids from de-inking processes are increasingly being used in Quebec (Canada) to improve acid soil. The objective of this study is to determine the optimum rates of de-inking paper sludge (DPS) for attaining target soil pH values of 5.2 and 5.5 for potato grown on podzolic soil. Incubation experiment was conducted during 18 weeks with a coarse textured soil (pH 4.8) and increasing rates of $CaCO_3$ or DPS. Results indicate that the amounts of DPS required varied from 4.0 to 8.2 dry Mg DPS ha^{-1} for attaining pH 5.2 and from 7.6 to 15.2 dry Mg DPS ha^{-1} for attaining pH 5.5. The required amount of DPS is proportional to its total $CaCO_3$ equivalent.

Key words: Liming materials, Soil amendment, Soil acidity, Lime requirement.

Introduction

The most common problem associated with acid coarse-textured soils in the province of Quebec (Canada) is aluminum (Al) toxicity particularly in soils devoted to potato (*Solanum tuberosum* L.) cultivation with pH below 5.5. Potato producers often attack this problem with soil amendments or liming materials. However, liming acid soils devoted to potato cultivation above 5.2 constitute a potential risk of scab disease especially for sensitive cultivars and soils infested with *S. scabies*. Although planting scab-tolerant potato is a reasonable option for dealing with acid soils and scab disease, liming is traditionally used to enhance pH to 5.5 in order to reduce Al availability and to improve soil productivity. Soils infested with *S. scabies* may be managed by adjusting the soil pH to a point unfavorable to the scab organism (Waterer, 2010).

In Quebec, about 74 000 Mg of primary de-inking paper sludge (DPS) were used in 2010 as soil amendment in crop plants (MDDEP 2010). This DPS contains cellulose fibers, removed inks, clay fillers (Barriga et al., 2010), coatings of used paper by a de-inking process (Charest and Beauchamp, 2002) and chemical additives added during the manufacture of paper, printing, and recycling (Beauchamp et al., 2002). Due to its high content of calcium carbonate, DPS may help reduce the use of commercial lime to treat acidic coarse-textured soils. DPS has been used to reduce soil acidity and availability of toxic Al (Baziramakenga et al., 2001; Battaglia et al., 2007), to enhance biological functioning (Chantigny et al., 1999), and to improve soil fertility (Fierro et al., 1997) and physical properties of soils (Trépanier et al., 1996; Chantigny et al., 1999).

Although the optimum pH range commonly reported for potatoes is 5.5 to 7.5 (Smith 1940), a soil pH of 5.2 to 6.2 is typical for commercial potato production in Quebec (CRAAQ, 2010). Potato is an important crop in Quebec's agricultural economy. The aim of the present experiment was to determine the optimum rates of DPS for attaining target sandy loam soil pH values of 5.2 and 5.5.

Materials and Method

Three types of primary de-inking paper sludge (DPS) were collected from three Cascade factories in Canada, namely Breakey fibers (DPS1), Candiac (DPS2) and Kingsey Falls (DPS3). DPS were air-dried, mixed, homogenized and ground to pass a 2 mm sieve prior to analysis for total C, total N and total Ca. Briefly, DPS1 contained 45% organic matter (OM), 0.2% total N and 16.1% total Ca; DPS2 contained 44.0% OM, 0.14% total N and 14.1% total Ca; DPS3 contained 52.0% OM, 0.12% total N and 12.7% total Ca. The pH was 8.0, 7.8 and 8.2 for DPS1, DPS2 and DPS3, respectively. The total calcium carbonate equivalent (TCCE) (BNQ, 2005) was 45.0, 42.0 and 37.5 for DPS1, DPS2 and DPS3, respectively. All analyses were done in triplicate. The pH of DPS was measured in deionised water using 1:10 DPS to water ratio. The Morin sandy loam soil (humo-ferric podzol) used for soil-liming material mixtures was taken from Patates Dolbec inc. farm in St-Ubalde (Quebec, Canada). Selected properties of the soil were as follows: sand 72%; clay 4%, pH_{water} (1:1 soil:distilled water ratio) 4.8; buffered pH or pH_{SMP} 5.6; organic matter 4%, Mehlich-3-extractable Al 1888 mg kg^{-1}.

Incubation test

The incubation experiment was planned using randomized block design containing three replicates for each test (chemically pure $CaCO_3$ ground to pass a 400 mesh sieve, DPS) and control treatment (without $CaCO_3$ or DPS). The treatments consisted of six $CaCO_3$ rates (1.1, 2.2, 3.4, 4.5, 6.7, and 9.0 Mg $CaCO_3$ ha^{-1}) and three rates of DPS: Breaky fibers (0.0, 10.0, and 20.0 Mg ha^{-1}, dry basis), Candiac (10.5 and 21.0 Mg ha^{-1}, dry basis) and Kingsey Falls (12.0, and 24.0 Mg ha^{-1}, dry basis). One kg of air-dried soil samples were placed into 1.5 L polypropylene recipients with drainage holes. A filter paper was deposited in the bottom of each recipient to prevent nutrient leaching. The soil was thoroughly mixed with reagent-grade $CaCO_3$ or DPS. Soil samples were moistened until water flows through the drainage holes. The moisture was adjusted every week by adding de-ionized water. All treatments were incubated in triplicate at 23 ± 2°C for 18 weeks.

Results

Increasing $CaCO_3$ or DPS rates significantly raised the soil pH after 18 weeks of incubation (Fig. 1). The pH of soil amended with $CaCO_3$ or DPS varied from 4.8 to 6.6. Soil samples amended with liming materials ($CaCO_3$ or DPS) exhibited the same pH response pattern. The four curves shown in Figure 1 are the best-fit asymptotic regression curves describing the relationship between $CaCO_3$ or DPS rates and pH of incubated soil samples. These relationships were significantly described ($P < 0.05$) by means of quadratic model: $pH = aX^2+bX+C$ (R^2: 0.91-0.99), where X is the rate of $CaCO_3$ or DPS rate and a, b and c are constants. Soil pH increased with the rate of DPS in the following order: Breakey fibers > Candiac > Kingsey falls. The first target pH of 5.2 is attained by adding 4.0, 5.3 and 8.2 Mg ha^{-1} of Breakey fibers, Candiac and Kingsey falls, respectively. The second target pH of 5.5 is attained by adding 7.6, 10.3 and 15.2 Mg ha^{-1} of Breakey fibers, Candiac and Kingsey falls, respectively. For calcitic limestone, soil pH values of 5.2 and 5.5 were attained by adding 2.6 and 4.6 Mg $CaCO_3$ ha^{-1}, respectively. The effectiveness of DPS in neutralizing soil acidity is negatively proportional to their TCCE value (Fig. 2).

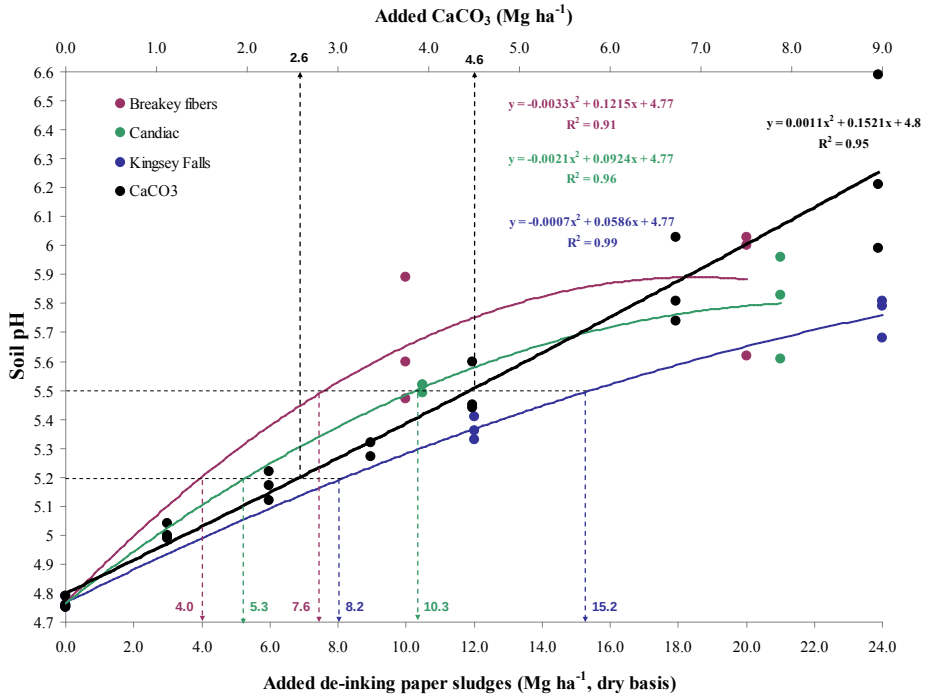

Figure 1: Graphic method for determining the amount of $CaCO_3$ and de-inking paper sludge (Breakey fibers, Candiac and Kingsey Falls) needed to reach soil pH values of 5.2 and 5.5.

Discussion

Strongly acidic soils and soils with a high buffering capacity often require a large quantity of lime. The amount of lime required to raise soil pH to 5.5, noted $LR_{5.5}$, is usually estimated in Quebec (Canada) by the recommendation system using pH_{SMP} as the diagnostic index of lime requirement (Table 1). According to this system, the amount of liming material that must be applied to the coarse-textured soil with a pH_{SMP} of 5.6 in order to reach soil pH_{water} of 5.5 was 7.1 meq per 100g (Tran and van Lierop, 1982) or 7.8 Mg $CaCO_3$ ha^{-1} (CRAAQ, 2010), substantially larger than the value of 4.6 Mg $CaCO_3$ ha^{-1} derived from soil-$CaCO_3$-moist incubation LR method (Fig. 1). This amount is somewhat close to 3.8 and 5.3 Mg ha^{-1} predicted respectively from Webber et al. (1977) and Soon and Bates (1986) equations (Table 1).

Table 1: Lime recommendation equations for Canadian mineral soils based on SMP soil-buffer pH.

References	Number of samples	Provenance	Soil type	Equilibrium period	Equations of lime requirement	r^2
Tran and van Lierop (1982)	37	Quebec soils	Coarse-textured soils	3 months	LR(5.5)* = 4.0 (pH_{SMP})2 -54.7 (pH_{SMP}) + 188	0.894
Soon and Bates (1986)	24	Ontarian soils	Loamy sand to clay	72 hours	LR(5.5)* = 3.66 (pH_{SMP})2 -48.98 (pH_{SMP}) + 164.3	0.828
Webber et al. (1977)	39	Candaian soils	Loamy sand to clay	30 days	LR(5.5)# = 3.4 (pH_{SMP}) + 23.3	0.740

* LR(5.5) in meq $CaCO_3$ per 100 g soil

\# LR(5.5) in t $CaCO_3$ per acre

This result indicates that the current recommendation system (Table 1) overestimates the lime requirement of the sandy loam soil by 3.2 (7.8-4.6) Mg $CaCO_3$ ha^{-1}. Excess amount of lime can be expected to increase soil pH to 6.0 rather than target pH value of 5.5 (Fig. 1) which would constitute a potential risk of scab disease especially for sensitive cultivars.

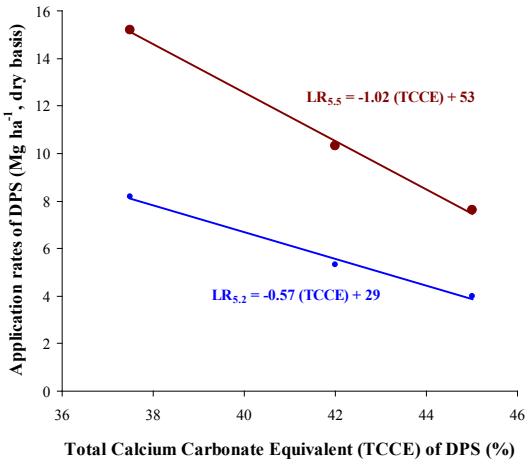

Figure 2: Application rates of DPS relative to their total calcium carbonate (TCCE) and target soil pH for potato crop.

As would be expected, Breakey fibers with the highest TCCE (45.0%) had greater effectiveness to attain the optimum pH range for potato plant than Candiac with TCCE of 42.0% and Kingsey Falls with TCCE of 37.5%. A one percent change in the TCCE of DPS could vary $LR_{5.5}$ and $LR_{5.2}$ by one and one half Mg DPS ha^{-1} (Fig. 2). TCCE values are probably related to the origin of recycled paper. Therefore, the amount of DPS required varies, depending on liming value of DPS and target pH value for potato crop.

Conclusions

The results indicated that the current Quebec recommendation system overestimate the lime requirement of coarse-textured soil.

The amounts (Mg ha^{-1}, dry basis) of DPS that must be applied to the coarse-textured soil with a pH_{water} of 4.8 in order to reach soil pH_{water} of 5.2 and 5.5 were respectively in the following range: 4.0-8.2 and 7.6-15.2. The amounts of DPS were negatively proportional to their TCCE value. Results also revealed that DPS were as efficient as $CaCO_3$ to neutralize soil acidity.

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Development of a GIS based hazardous road location identification system for National Highways of Bangladesh

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Abstract: Developing countries like Bangladesh are now facing a serious road safety crisis and without giving severe importance with significant improvement in the relevant sector, the problem will be worsen in the coming years. Recent analyses illustrate that road crashes are normally clustered in some specific sites, routs or locations and now the main challenge is to find out those locations exactly. Traditional analysis techniques do not have any spatial referencing with the road network but only shows some historical database to identify the crashes locations. Consequently, it's become difficult to find out the crash locations for the time being. A GIS based smart road safety system with digitize road network can help us to identify the crash locations on road which will lead us to locate the hazardous road locations (HRL) after some spatial query. Specific treatments at those locations can greatly reduce the overall number of road crashes. Under this circumstance this study will provide an effective method to identify and analysis of hazardous road locations in national highways of Bangladesh by a digitized road map exclusively for crash investigation using Geographic Information System (GIS). A case study also provided on a national highway, Dhaka-Aricha to verify the method. Crash data has been analyzed for three years, 2008-2010. Criteria of HRL identification is set as the locations where the number of fatal crashes in 0.1 Km to 0.5 Km of road over a period of 3 years equals or exceeds 3 crashes. Characteristics analysis carried also on some selected spots to understand the actual facts behind the crash on those locations with some general countermeasure to twist the locations safe. This low cost method of identification can be used in other national highways of Bangladesh and also in other countries as well because of its easy adoption and compatible nature.

Key word: Road crashes, hazardous road location, Geographic Information System (GIS).

Introduction

Road Traffic Crashes (RTC) comprises a major public health problem in world wide. According to WHO, leading cause of deaths and the 9th leading contributory factor to the burden of disease all around and the situation will be worsen in coming days. About 1.2 million human fatalities are estimated with almost 50 million are injured. It is predicting that this number will rise by about 65% over the next 20 years unless new measures to prevent the hazard are taken (Rahman, 2006, p.24). Most of the case the safety measures to prevent RTC using in developed countries is not compatible for low and middle income countries due to the difference between social, cultural, economic and behavioral distinction. Detailed analyses of global crash statistics indicate that, however, that low and middle income country is accounted for about 90% of all road crashes in recent years when fatality rates per licensed vehicle are very high in comparison with the industrialized countries. Moreover, road crashes have been shown to cost around 1% of annual gross national product (GNP) resources of the developing countries, which they can ill-afford to lose. Hence it is necessary to incorporate steps, which can reduce road crash rates and implement mitigating actions.

Like other developing countries, Road Traffic Crashes are causing a serious concern in Bangladesh when developed and a good number of developing countries are improving the situation. Present road crash analyis system is

confined only some kinds of historical database having a little scope for scientific analysis with those data and what is worth, there is no clear or a gray area to identify the crash prone locations or hazardous locations or black spots, which is now a prime requirement for careful investigation and comprehensive study to solve the epidemiological nature of road crashes.

The road crashes are normally clustered in some specific sites, routs or locations. Hazardous location or locations mean abnormal concentrations of crashes occurrences in some particular road length within the route. At present, in our country the crash locations are manually marked and written by police in crash record form. For this, however, sometimes the exact crash location does not match with the written location or the location does not find out at all. Crash data collected for many years serve as the ground base for program designed to reduce the number of traffic crash. These crashes database are usually in the form of linear record file system, which enable an extensive amount of research using statistical methods, but both the database as well as the analyzed information lacked visibility, which is now one of the primary requirements in a smart technical analysis for better understanding and good decision making. To build a smart road safety system we need to go for modern technology like Geographic Information System (GIS) with a digitized road network especially for road crash analysis where every road segment have their attribute and analyzed separately.

In Bangladesh, we don't have any digitize road map or vector map exclusively for road traffic crash analyses. The digitize map which is using for other purpose have lack of spatial information of every road segment that's why it cannot co-relate with the crash data from police. Geographic Information System (GIS) has been identified as an excellent system for storing and managing these types of data and also as a potential tool from improving crashes analysis process. One of the main reasons is that it provides an efficient system of linking a large number of disparate databases and also provides a spatial referencing system for reporting output at different levels of aggregation (Peled, A. & Hakkert, A.S, 1982). A digitize road network can help us to identify the crash locations on spot and from here we can authentically locate the crash prone locations or hazardous road locations in a road. Specific treatments at such locations can greatly reduce the overall number of road crashes. This type of effective and low cost technology is now a an urgent need for our country and under this circumstance this study will provide an effective system to identify and analysis of hazardous road locations in national highways by a digitized road map exclusively for crash investigation using Geographic Information System (GIS).

In Bangladesh, until recently, very little work has been done to focus on a detailed spectrum of analyses of road crashes for a reasonably full understanding of the crash problems and thereby developing effective countermeasures. Crash data recorded from 2008 to 2010 by the Crash Research Institute (ARI), BUET, has been used as the basis for the study. This study focuses on hazardous road locations on Dhaka-Aricha-Banglabandh national highway named as N-5 plays a vital role in inter-district and interregional transport as it connects the northern and western regions of Bangladesh with Dhaka, the national capital. The length of the road is 513km and has a great effect on national economy and transport. This corridor has chosen for the case study because of its recent crash statics. Total 2594 no. of crashes occurs in between year 2000 to 2010 with 2445 fatalities and 2202 injured and it is also happening in recent year. From the year 2008 to 2010 total number of crashes are 419 with 557 fatalities and 375 injured (ARI Database, 2011).

Figure 1: Dhaka-Aricha-Banglabandh (N-5) National Highway

Materials and Method

Apart from the sufferings and pain road crashes are huge financial burdens for governments at all levels. Several programs and methods have been taken by the authority to mitigate the crisis. However, these program and traditional methods have some limitation. The accurate location of crashes is often miss-coded wrongly, street names spelt, street number code may be wrongly coded. Further difficulties include the lack of common referencing system, lack of consideration of the special analysis and are labor intensive and time consuming (Prastacos, 1991). All these make the identification of high crash road section more difficult especially for the traditional computerized programs now in use. These could also lead to wrong section of roads being identified as hazardous if not the wrongly coded crashes are identified on time.

GIS is found to be suitable for such analysis and able to overcome these handicaps. It has the capability to integrate data from various sources and generate useful information upon which sound decision can be based. GIS in road crash analysis and safety, enhance efficiency in data collection with errors identification at an early stage for prompt action. As a consequence, generation of good quality crash locations plots; and improves decision making by serving as a decision- support system. Data in GIS system for road safety improvement are generally stored in separate thematic layers. Each layer represents theme of the overall system and comprises spatial information and non- spatial information stored in the system database, and sometime auxiliary files (Affum J. K., 1992). All these are linked together to established of georeferenced database. The second phase of the system analysis focused on the use, reconstruction, and accessibility to various data elements. This methodology made it possible to implement most of the queries in a simple and rapid manner, where only in a "microtype" analysis does the system need to select the information contained in the auxiliary files (Lubkin, J.L. 1989).

This study was based primarily on a specially created crash form by Bangladesh police. The form was designed for easier completion and it's fully compatible with crash analysis package MAAP (Microcomputer crash analysis package). The person filling in this form simply needs to circle the relevant value for each crash parameter which has been conveniently classified into various sections. This information is manually keyed in into MAAP using the programmed option available in MAAP. In order to model the mentioned factors and achieve the desired result, a step-by-step procedure as given below has adopted.

- Scan the map containing the desired road network and input this image to ArcMap for digitizing (convert Raster map to Vector map). Because for spatial analysis a digitized map is required.
- Draw vector maps of all the national highways (N1-N8). The projection system used in this study is BTM coordinate system.
- Divide the Dhaka-Aricha-Banglabandh (N-5) national highways with an equal distance of 100m. Digitize the road network with due consideration for separation of every link (100m) and assign “id” number to every link.
- Preparation of crash database for the year 2008-2010. In this study crash data has been collected from crash research institute, BUET.
- Export the crash attribute table in dbase format so that it can be imported by ArcMap.
- Join the road attribute table to the crash database and prioritize the raod network for crash occurrence using total weights assigned to every link
- Create shapefile of crashs for the year 2008-2010
- Query on shapefiles to visualize crash on the road
- Combine the results obtained query analysis to determine the hazardous road location on the road network. There are many criteria’s to select hazardous road location. The identification criteria in this study is, firstly the locations where the number of fatal crashs in 0.1 Km to 0.5 Km of road over a period of 3 years equals or exceeds 3 crashs are identified. Upon further analysis, adjacent locations (within 3 km) with fairly high crashs were aggregated to one hazardous location.

- Characteristics analysis of selected hazardous road locations in national highway. This will help to understand the crash scenario of those roads which will assist in implementation of safety measures of those locations.

Site study showed that some kilometer post sign are not exact which lead the police officers to identity the kilometer post. Therefore in the study some crash locations are not in exact place.

Results

Amongst elements in accident information, the most important element, from engineering point of view, is the exact location identification which is a pre-requisite to identification of hazardous location or black spots. Accidents locations of the highway have shown in figure 2 on road network.

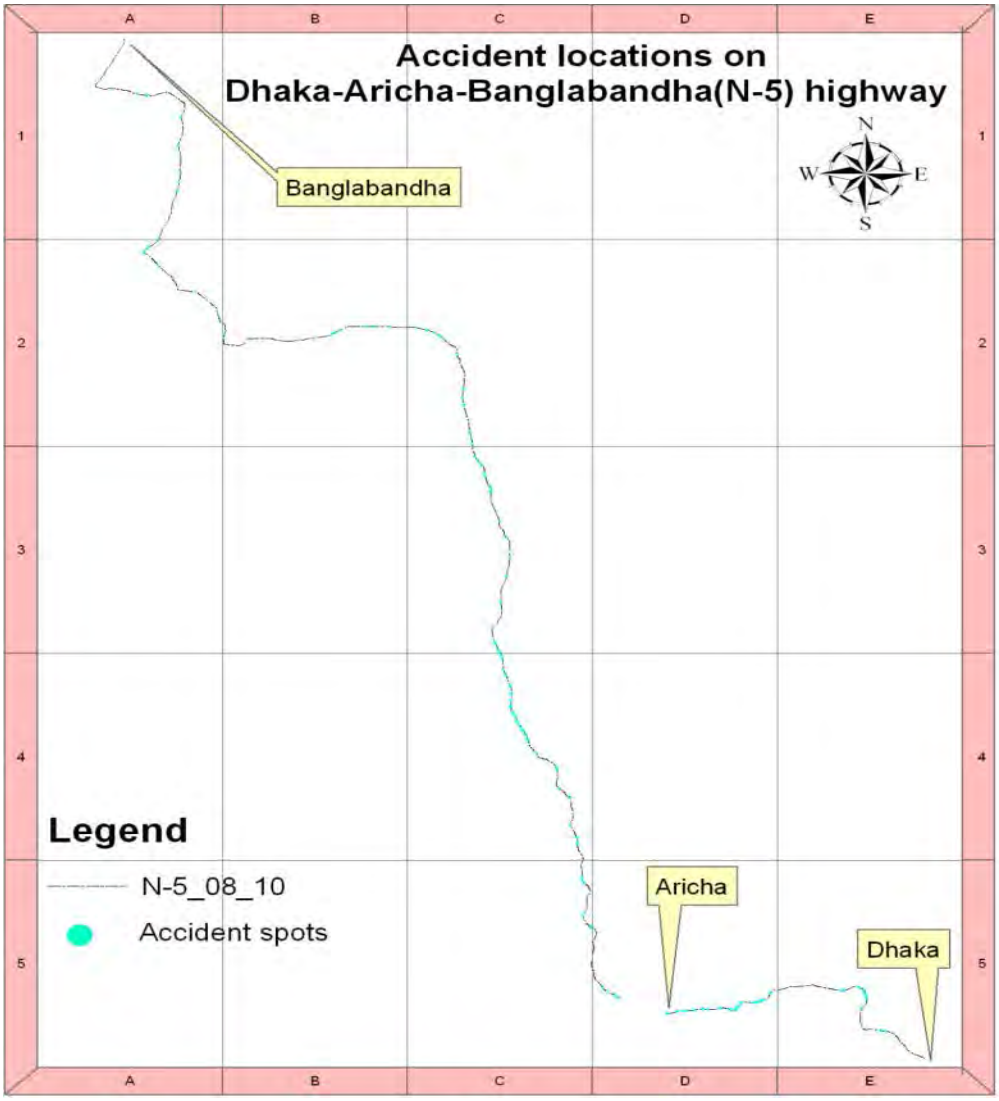

Figure 2: Accident locations on Dhaka-Aricha-Banglabandh (N-5) National Highway

From figure 2 it's clearly visualize that crashes have taken place all over the road though there are some successive segments of road where crashes are in a row. In this figure crashes are have shown in a common identity but to find hazardous road locations or black spots, locations should be analyzed by number of accidents.

In this study for analysis purpose, however, Dhaka-Aricha-Banglabandh national highway is analyzed by two separate sections. First one is eastern side of the river Padma is from Dhaka-Aricha named as N-5(E) which is 87 km long and second portion is western side of the Padma river from Aricha-Banglabandh named as N-5 (w) is 426 Km. This highway encompasses varied geometrical and environmental condition.

Hazardous Locations on Dhaka-Aricha, N-5(E)

From the year 2008 to 2010 total 63 accidents occurred; when majority of these are fatal accidents. 52 fatal accidents have occurred during the time period. Accident scenario of this road segment has given below in table 1. Here, id is for georeferencing link with road shape file and "FA08_10", "NFA08_10" and "TA08_10" is successively represents the number of fatal accident, non fatal accidents and total accidents.

Table 1: Accident statistics of Dhaka-Aricha, N-5(E) highway

Id	Km	FA08_10	NFA08_10	TA08_10	Id	Km	FA08_10	NFA08_10	TA08_10
618	61.7	6	2	8	386	38.5	1	0	1
671	67	6	1	7	579	57.8	1	0	1
577	57.6	4	0	4	605	60.4	1	0	1
768	76.7	4	0	4	613	61.2	1	0	1
824	82.3	3	0	3	627	62.6	1	0	1
311	31	2	0	2	665	66.4	1	0	1
634	63.3	2	2	4	672	67.1	1	0	1
682	68.1	2	0	2	684	68.3	1	0	1
707	70.6	2	1	3	686	68.5	1	2	3
737	73.6	2	0	2	781	78	1	1	2
137	13.6	1	0	1	803	80.2	1	1	2
150	14.9	1	0	1	847	84.6	1	0	1
263	26.2	1	0	1	873	87.2	1	0	1
308	30.7	1	0	1	874	87.3	1	1	2
324	32.3	1	0	1	**Total**	**2.9km**	**52**	**11**	**63**

From the table it's found that among the total 87 km road length accident only occur at 2.9 km of road length. This crashes information has linked with the road network shape file with GIS to locate the hazardous location on road. After this the accident spots is possible to pin-pointed on map. Figure 3 shows the hazardous road locations on Dhaka-Aricha section of highway.

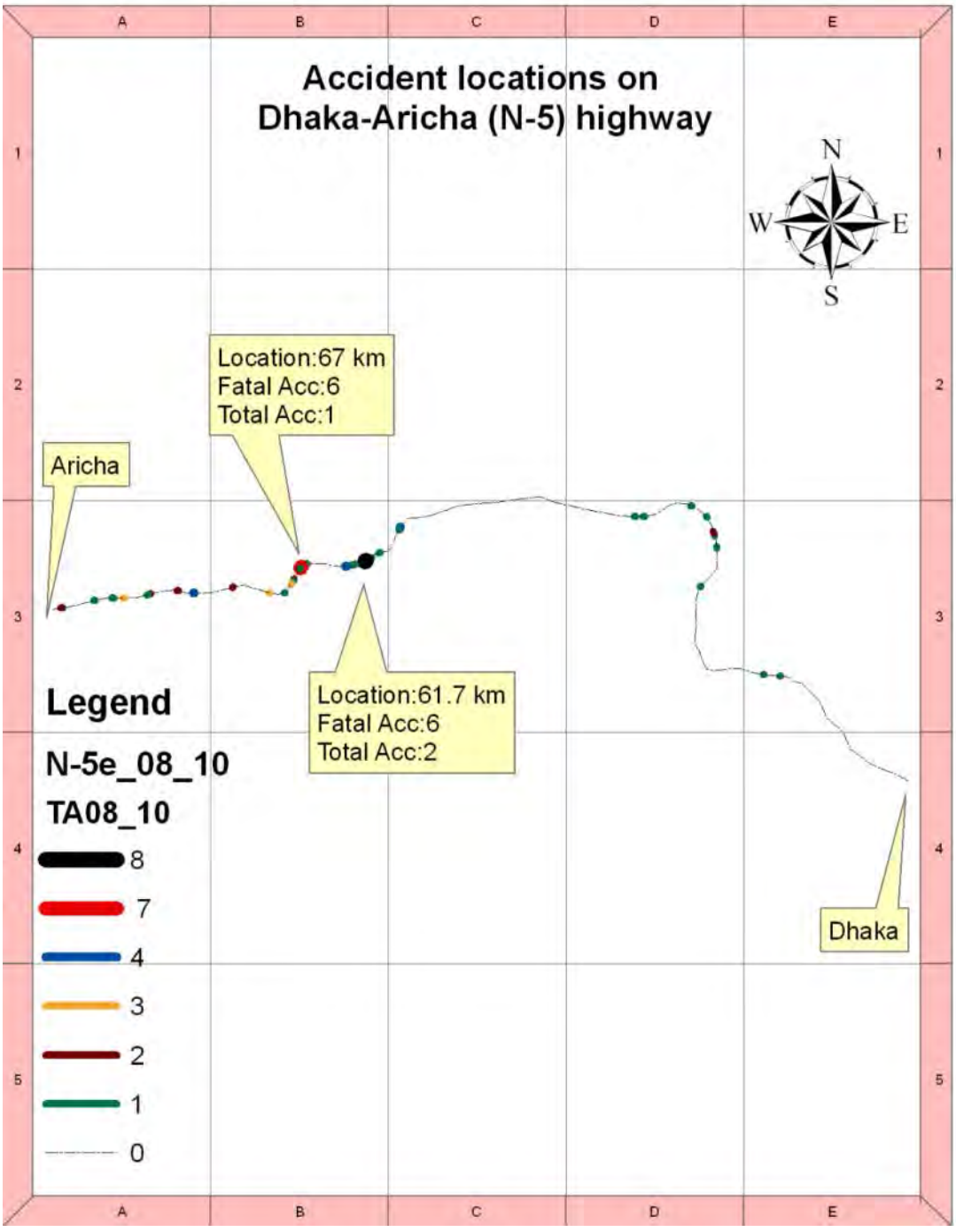

Figure 3: Hazardous locations on Dhaka-Aricha, N-5 (E) National Highway

This figure shows crashes location on road with number which indicates five hazardous locations with km value 57.6, 61.7, 67, 76.7 and 82.3 respectively. From here two locations can be treated as most hazardous. First one is, 61.7 km from Dhaka where total 8 crashes occur during the year 2008 to 2010 when no. of fatal accident is 6. And the second one is, 67 km from Dhaka where total 7 crashes occur and among them fatal crashes is no. 6. First location is a bridge and second one is near a bus stand named kazla bus stand.

Hazardous Locations on Aricha- Banglabandha, N-5(W)

From the year 2008 to 2010 total 129 accidents occurred; when majority of these are fatal accidents. 102 fatal accidents have occurred during the time period. Accident scenario of this road segment has given below in table 2.

Table 2: Accident statistics of Aricha-Banglabandha, N-5(W) highway

Id	Km	FA08_10	NFA08_10	TA08_10	Id	Km	FA08_10	NFA08_10	TA08_10
1250	228.9	4	0	4	1270	230.9	1	0	1
618	165.7	3	1	4	1281	232	1	0	1
1958	299.7	3	0	3	1495	253.4	1	0	1
2119	315.8	3	0	3	1581	262	1	0	1
35	107.4	2	0	2	1624	266.3	1	0	1
1061	210	2	0	2	1681	272	1	0	1
1221	226	2	0	2	1778	281.7	1	0	1
1413	245.2	2	0	2	1781	282	1	0	1
1840	287.9	2	0	2	1830	286.9	1	0	1
3265	430.4	2	0	2	1869	290.8	1	2	3
3606	464.5	2	0	2	1886	292.5	1	0	1
1	104	1	0	1	1941	298	1	0	1
11	105	1	0	1	2088	312.7	1	0	1
52	109.1	1	0	1	2231	327	1	0	1
266	130.5	1	0	1	2301	334	1	0	1
307	134.6	1	1	2	2311	335	1	1	2
319	135.8	1	0	1	2313	335.2	1	0	1
425	146.4	1	1	2	2332	337.1	1	0	1
436	147.5	1	0	1	2352	339.1	1	0	1
558	159.7	1	0	1	2380	341.9	1	0	1
575	161.4	1	0	1	2493	353.2	1	1	2
709	174.8	1	0	1	2515	355.4	1	0	1
751	179	1	0	1	2517	355.6	1	1	2
815	185.4	1	0	1	2601	364	1	0	1
821	186	1	0	1	2607	364.6	1	0	1
899	193.8	1	0	1	2609	364.8	1	0	1
944	198.3	1	0	1	2619	365.8	1	0	1
949	198.8	1	0	1	2620	365.9	1	0	1
965	200.4	1	0	1	2835	387.4	1	0	1
977	201.6	1	0	1	2953	399.2	1	0	1
984	202.3	1	0	1	3006	404.5	1	0	1
991	203	1	0	1	3319	435.8	1	0	1
1010	204.9	1	0	1	3345	438.4	1	0	1
1012	205.1	1	0	1	3374	441.3	1	0	1
1028	206.7	1	0	1	3545	458.4	1	0	1

1037	207.6	1	0	1	3546	458.5	1	0	1
1041	208	1	0	1	3688	472.7	1	0	1
1065	210.4	1	0	1	3781	482	1	0	1
1083	212.2	1	0	1	3942	498.1	1	0	1
1103	214.2	1	1	2	3968	500.7	1	0	1
1108	214.7	1	0	1	4040	507.9	1	0	1
1131	217	1	0	1	4085	512.4	1	0	1
1165	220.4	1	0	1	**Total**	**8.6 km**	**102**	**27**	**129**
1181	222	1	0	1					

Like the previous one it's found that among the 426 km road, accident only occur at 8.6 km of road length. This crashes information has linked with the road network shape file with GIS to locate the hazardous location on road. Figure 4 shows the hazardous road locations on Dhaka-Aricha section of highway

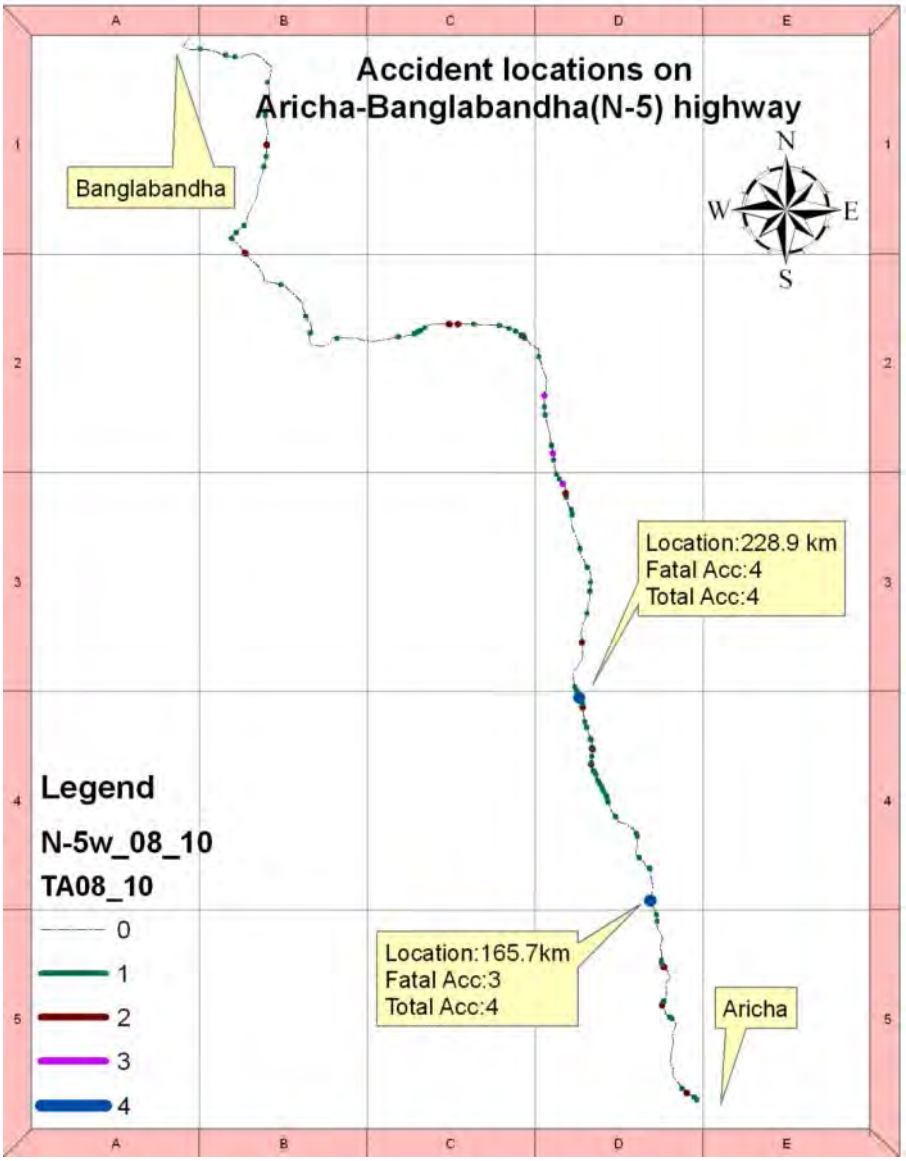

Figure 4: Hazardous locations on Aricha-Banglabandha, N-5(W), National Highway

This figure shows crashes location on road with crashes number. Here four locations are identified as hazardous whose distance from Dhaka is 165.7km, 228.9km, 299.7km and 315.8km respectively. From here two locations can be treated as most hazardous. First one is, 165.7 km from Dhaka where total 4 crashes occur during the year 2008 to 2010 when no. of fatal accident is 3. And the second one is, 228.9 km from Dhaka where total 4 crashes occur and among them fatal crashes is no. 4. First location is hatikamrul bus stand and second one is near a bus stand named baghopara bus stand.

The scenario extracts from the above analysis illustrates that bus stands are playing a main role in hazardous road location. May be the reason is for local unsafe activities around the bus stopes with aggressive driving. To find the exact causes which make those segments hazardous, an extensive characteristics analysis is required.

Discussion

The above analysis revealed four most hazardous locations which should be examined very carefully to understand the crash behavior to mitigate the risk. Here crash characteristics of those most hazardous locations would be analyzed.

Location 61.7 km (Bridge)

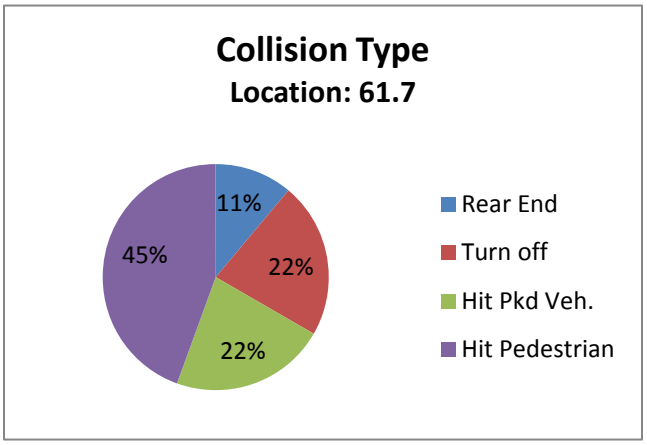

Figure 5: Collision type of location 61.7km

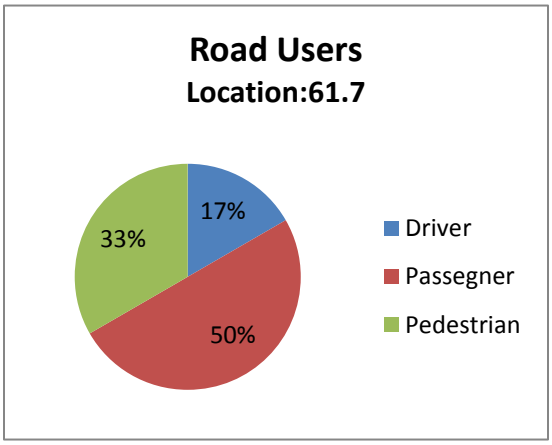

Figure 6: Casualties of location 61.7km

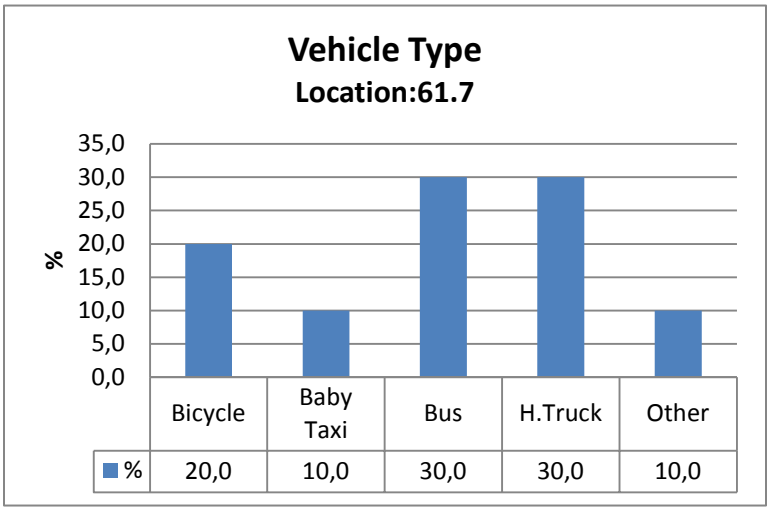

Figure 7: Vehicle involvement of location 61.7km

From the figure 5, 6, 7; it's seen that hit pedestrian is the highest no of collision type with 45% crashes. Turn off vehicle and hit parked vehicle are next in position with an equal sharing of crashes as 22% but interestingly passenger casualty is higher (50%) then pedistrian casualty (33%). Involvements of bus and trucks are the highest with an equal no. 30% when bicycle comes after them with 20%.

Location 67km (kazla bus stand)

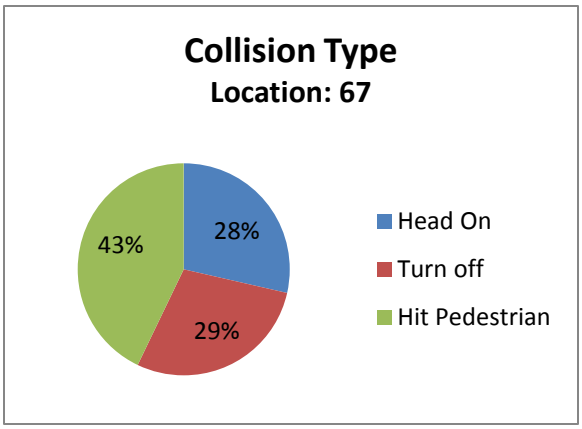

Figure 8: Collision type of location 67km

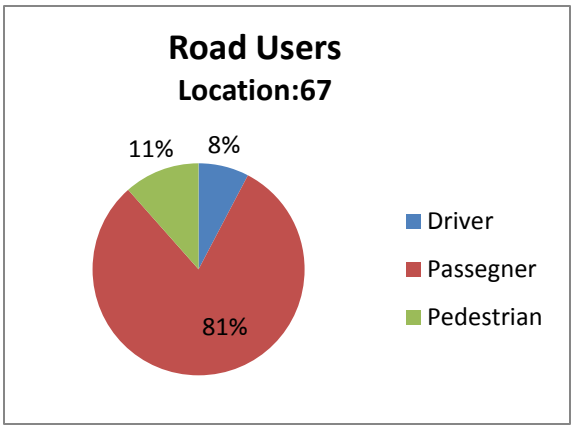

Figure 9: Casualties of location 67km

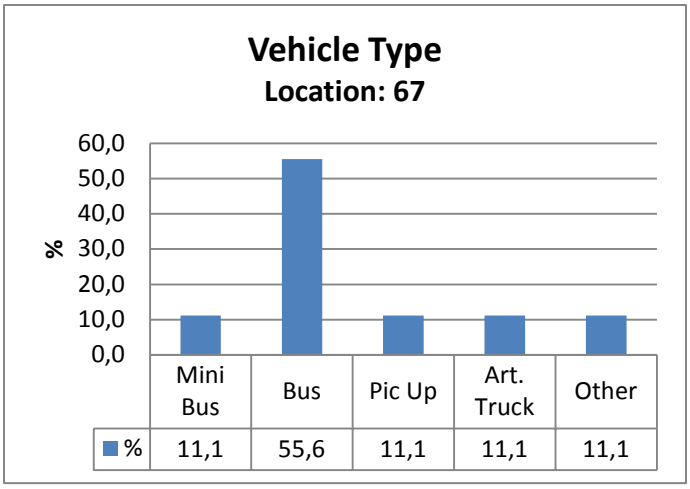

Figure 10: Vehicle involvement of location 67km

From the figure 8, 9 and 10; it's seen that hit pedestrian is the highest no of collision type with 43% crashes. Turn off vehicle and head on are next in position with almost equal sharing of crashes as 29% and 28% respectively. Pedestrian casualty is most significant like81% when passenger and driver casualties are very little. Involvements of bus in crashes are the highest then other vehicle with about 57%.

Location 165.7km (hatikamrul bus stand)

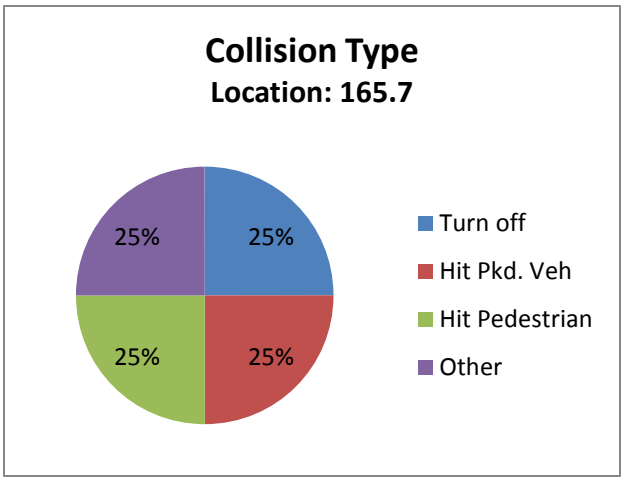

Figure 11: Collision type of location 165.7km

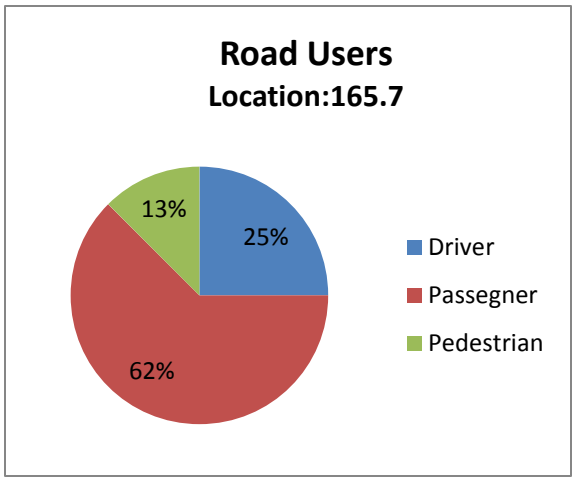

Figure 12: Casualties of location 165.7km

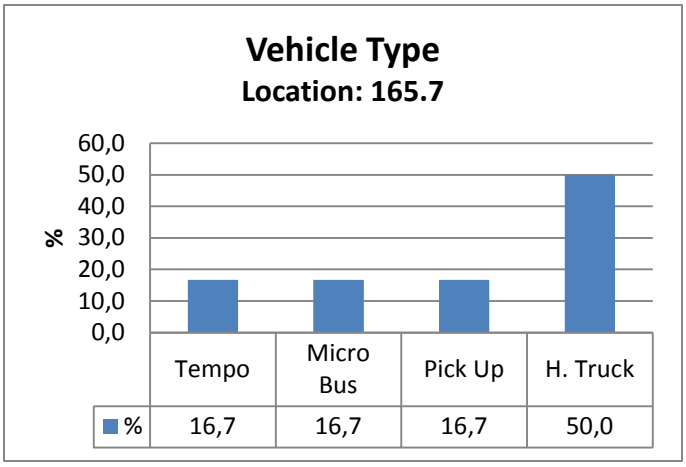

Figure 13: Vehicle involvement of location 165.7km

From the figure 11, 12, 13; it's seen that hit pedestrian, turn off, hit parked vehicle and others type of collisions are sharing equal role in this segment with 25% crashes but interestingly pedistrian casualty is higher (62%) then other though driver casualty comes after next (25%). Involvements of heavy trucks are the highest with 50% sharing then other vehicles.

Location 228.9km (baghopara bus stand)

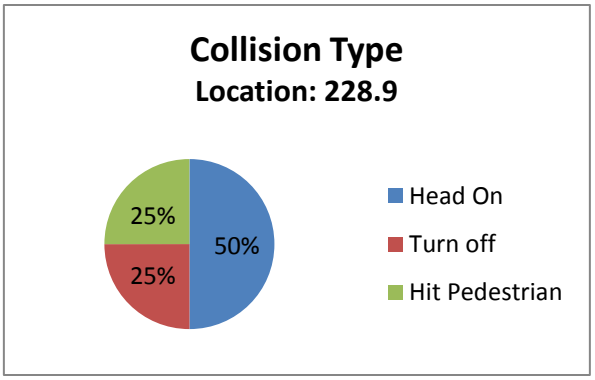

Figure 14: Collision type of location 228.9km

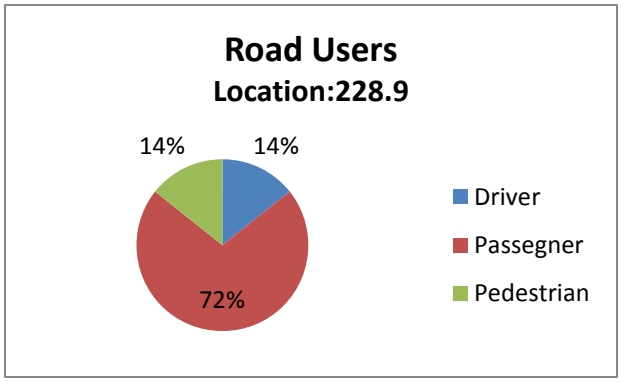

Figure 15: Casualties of location 228.9

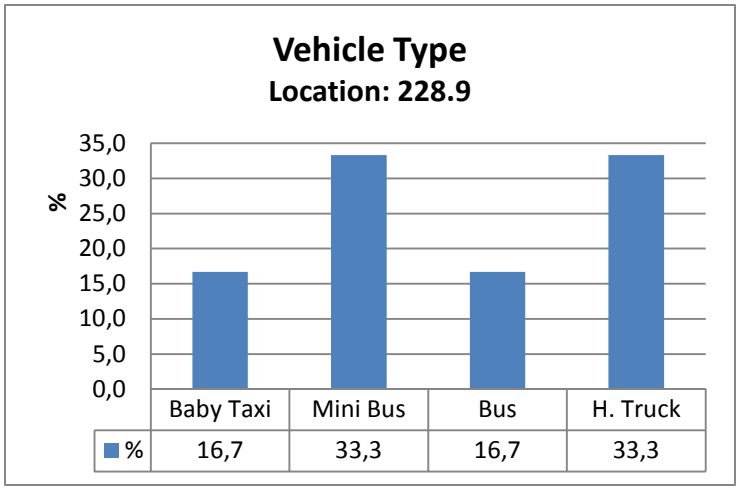

Figure 16: Vehicle involvement of location 228.9

Unlike previous segment from the figure 14, 15, 16; it's seen that head on collisions (50%) dominates then other collision like turn off and hit pedestrian which effects on road user casualty chart which illustrate significant passenger casualty (72%). Most of the vehicle involves in crashes in this segments are heavy trucks and the mini-bus with 33% of crashes.

In sum, it can be said that all the segments are very much vulnerable for pedestrian followed by head on collisions as well. Specific safety measures should be implemented to make those segments safe both for pedestrian and passengers after extensive field survey.

Conclusions

Road safety has been an increasing concern to community in recent years in Bangladesh. This paper has discussed about the implementation of GIS in crashes analysis to make an effective way of analysis and represent the accident with the exact location and verification of the method for a major highway of Bangladesh. In the period of 2008 – 2010, crashes occurred in only 2.2 percent length of N-5 which clearly demonstrates that accidents are amenable to targeted and site specific. Four specific sections of these two national highways worthy of being treated as hazardous locations have been identified. In recent years, Dhaka-Aricha-Banglabandha highways have become very busy roads as it passes through three divisions of Bangladesh. On the basis of the results and findings, the necessary remedial measures should be provided to make the operation of this most important and widely used national highway (N-5) of Bangladesh safe and efficient. Some potential measures are as follows:

- Effective and user friendly pedestrian facility such as briar, overpass, underpass, zebra crossing, pedestrian signal etc should be established in those sections on the basis of its function. Also focus on speed reduction near bus stoppages also near schools, bazaar and residential should be considered.
- Head on and turn off collisions is also the dominating collision types at all the segments of the highway. Undivided highway, reckless overtaking are the main causes of head on collision. So divided highway and special overtaking sections should provided. To arrest the vehicle turning off, vehicle fitness should be examined frequently.
- Appropriate signs, road markings, fencing, guardrails, junction modifications, and improvements to visibility should be considered as remedial measure.
- Dangerous and inappropriate operation of heavy vehicles (buses and trucks) such as reckless overtaking, overloading and braking/stopping on roads and road sides are particularly a serious problem in all those segments. So, adequate enforcement should also be considered.

Acknowledgements

The approach presented here is aimed at the conception of an important database which will allow the analysis of road traffic crashes on our highways using Geographic Information System (GIS). This modern technology is a powerful tool which will facilitate fast retrieval of information and easy to update when the need arises. In addition, it has the capability of adapting to the changing needs of the road planners and engineers in the process of these technocrats would want to re-design the road transport facility for the safety of its users.

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Environmental cost management within the sustainable business

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Abstract: In the last fifty years, the concept of sustainable development which has important notions for researchers and businesses, without disregarding the needs of future generations, not ignoring the human needs, is a concept that aims to provide the basic needs of all society effectively. Thus, the activities that have been carried out by businesses are becoming more important.

Within the sustainable business, to become an organization environment and human friendly is important. Sustainable business needs protecting the environment which provides the factors of production. In short term, producing and selling goods without concerned with environmental costs makes profit to the business, but in long term, makes disadvantage initially to the business and environment. Throughout the activities of business, taking measures to reduce for harmful effects on the environment during the process of transformation from raw material to final product is a necessity of sustainable business.

In this study, the environmental cost management is analyzed within the activities of business to realize efficiently and effectively, to elevate market value and carrying to future. Moreover, organizational structure, activities and their effects on the environmental costs will be explained in the case that the activities of business to be sustainable and environment friendly organization.

Keywords: *Sustainable Business, Environmental Cost Management, Environmental Management Accounting*

Introduction

Enterprises are required to formulate their vision depending on the concept of sustainability. Activities of enterprises with a sustainable business vision will contribute to the enterprise environment and development of the society in which it operates. However, in order to maintain these activities, environmental factors should be also taken into consideration. Today, assessment and management of environmental costs which constitute one of the major cost items within the scope of the sustainability have great importance for businesses.

Since 1970s that is the beginning of conflict with the objectives of the concepts of economic growth and ecological sustainability; it is understood that economic growth and development is not itself sufficient to ensure the welfare of the community. As a result of environmental problems caused by industrialization it is accepted that environment is a source like other production factors and a value which may become polluted and exhausted over time. Besides, it is understood in this process that using the environment has a cost as well as the costs faced by businesses while using any source (Çelik, 2007).

Sustainability and Sustainable Development

Sustainability is a dynamic concept which does not have a generally accepted definition in the literature yet. In recent years, it attracts more interest from some certain parts of the society including especially academics, businesses and their environments (Roosa Stephen, 2010:81). However, sustainability is a concept involving all parts of society.

The rise of greenhouse gas emissions that emerged with industrialization brought factors such as climate change etc. and environmental disasters perceived on a global basis. In this developing process states sought a new model instead of the classical economic development model. As a first result of this search in

1987, the United Nations Stockholm Conference on the Human and the Environment sustainable development has been on the agenda for the first time. In this report, sustainability is defined as “development meeting the needs of todays without compromising the needs of future generations to meet their own needs" (WCED, 1987).

Another definition of sustainable development, it aims to use the resources effectively which are scarce for the welfare of present and future generations without destroying them through the creation of a fit about the sustainability of environmental, social and economic development (Hall, Daneke and Lenox, 2010). According to this definition, if environmental, social and economic developments do not take place in a harmony, it is not possible to talk about sustainability.

Sustainable Business

The main actors in the realization of sustainable development are businesses. Taking into consideration that businesses use natural resources to meet human needs and are economic units that contribute to economic, social and environmental improvements, their role in sustainable development understood better.

The concept of sustainability for businesses is discussed under social, economic and environmental dimensions. According to Aras (2012) sustainability, " is an extremely important indicator not only includes own internal factors of businesses, but also includes all external factors influence it and assessment of them."

In the name of sustainability, it is extremely important to determine a common way in the initiatives connected to the environmental awareness and the actors that is related along the chain starting with the supply of raw materials of businesses and up to the final goods and reaching the service to the consumers. Today, with globalization the effects of business activities go far beyond the time and place in which they are. In this context, while performing their activities businesses should act not only with an economic point of view, but also with a vision of sustainable business. The businesses which have the vision oversee the management of this process within the framework of environmental awareness (Altuğ et al., 2012).

The main objective of businesses to maximize profits in the short term and in the long term is to maximize shareholders' wealth. However, from the operation results of an enterprise affect not only the owners and its partners, but also affect the community, various institutions and organizations (Şengel, 2011). The activities of businesses are under pressure from these groups. Today, as the pressure increases day by day due to environmental factors (Aydın, 2012). In this context, businesses need to consider not only the economic dimension of their activities but also need to consider the social and environmental dimensions (Nowduri and Al-Dossary, 2012: Okka, 2005:15).

Exhibit-2-1: The Dimensions of Sustainable Business

Source: Yıldız T. 2006

The factors that need to be in order to have sustainable business activities (Benn et al., 2006):

- Being in contact with shareholders,
- To have the vision to draw a road map for the future,
- To achieve innovative capacity through clean energy
- To have the skills and capacity of risk reduction by increasing profit and preventing the environment damage.

Sustainable business development stages are presented in Table 2-2;

Table-2-2: Sustainable business development stages

PHASE	HUMAN SUSTAINABILITY	ECOLOGICAL SUSTAINABILITY
Step 1: Rejection	Employees and subcontractors exploited. Community concerns are rejected outright.	The environment is regarded as a free good to be exploited.
Step 2: Non-responsiveness	Financial and technological factors exclude broader social concerns.	Ecological factors are excluded from decision-making.
Step 3: Compliance	The emphasis is on compliance with legal requirements in industrial relations and safety.	Ecological issues unlikely to attract strong litigation or strong community action are ignored.
Step 4: Efficiency	Technical and supervisory training augmented with interpersonal skills training. Community projects and HR value-adding strategies are pursued only when a cost benefit to the company is obvious.	Environmental issues are ignored if they are not seen as generating avoidable costs or increasing inefficiencies. Sales of byproduct are encouraged.
Step 5: Strategic Pro-activity	Intellectual and social capital is used to develop strategic advantage through innovation in products/services.	Proactive environmental strategies such as product and process redesign are seen as a source of competitive advantage.
Step 6: The Sustaining Corporation	Key goals both inside and outside the firma re the pursuit of equity and human welfare and potential.	The firm works with society towards ecological renewal and positive sustainability policies.

Source: Benn S. et al. 2006

While sustainable development is associated with social, environmental and ethical issues, in terms of enterprise it is associated with corporate governance, corporate social responsibility and social accounting and can be integrated into enterprise (Mei, 2011).

Environmental Accounting

Environmental accounting is also called as Green Accounting is expressed in different terms in the literature. For example: Environmental Accounting, Natural Resource Accounting (NRA), Environmental Management Accounting (EMA), Full Cost Accounting and so on.

After 17th century rapid industrialization, urbanization, environmental pollution induced climate change and the opening of agricultural lands for settlement due to population growth have revealed environmental problems. In other words, the production activities in order to meet human needs caused environmental problems and began to be an evident manner all over the world. June 5, 1972 Stockholm Conference, which is a turning point in the international policies related to the environment, has revealed that the need to embrace the environmental problems should be at the universal level not at local or regional level (Kırlıoğlu and Yıldız, 2004).

In the second half of the 20th century, environmental issues have been a subject to scholars and regulations related to the business world. The concept of environmental accounting and related issues has been developed since 1970s and arrived to the present day (Todae et al, 2011).

In the last quarter of the 20th century environmental disasters such as Bhopal chemistry (1984) and the Exxon Valdez oil disasters (1989) revealed that continuation of only profit policy adopted by businesses would not provide the sustainability (Erkuş and Ateş, 2008, p.265). In 2010, in the explosion happened at British Petroleum (BP)'s drilling tower in the Gulf of Mexico 4.9 million barrels (779 million litres) of oil leaked into the sea at the end of 87 days. 48,000 people worked to prevent leakage threatening the environment and biodiversity and by the end of 2010 of $ 17.7 billion were spent. As a result of ongoing cases until 2012, U.S. Department of Justice fined BP 4.5 billion dollars. Even if the Gulf of Mexico is cleaned up today, the recycling of damaged ecological balance will take many years.

Today, it is obvious that accounting which is an open system in an ongoing relationship with the environment, cannot remain indifferent to social and environmental issues (Çelik, 2007). Environmental accounting can be considered as a sub-branch of cost accounting or an independent branch (Yakhou and Dorweiler, 2004).

Environmental organizations play an important role on the environmental regulations made on a national basis, the formation of environmental awareness in the community and accentuating of businesses on environmental issues. Environmental accounting does not yet have sufficient legality in the business world

despite being constantly on the agenda of academic conferences and taking parts in the publications of academics and in a variety of environmental protection organizations (Çelik, 2007).

Environmental accounting is to present the financial and non-financial information, obtained from the physical effects of businesses on the environment and their efforts to minimize these environmental effects, to the public (Antheaume, 2004).

There are different definitions in the literature on environmental accounting. U.S. Environmental Protection Agency (U.S. EPA) [1] defines environmental accounting (1995) as follows:

- Identification and disclosure of financial information related to environment to the public within the scope of financial accounting and reporting,
- The identification and use of environment-related physical and financial data within environmental management accounting,
- External environmental impacts and estimated costs,
- The physical and monetary accounting of the remaining and used natural resources,
- Data collection and reporting of accounting data for the purposes of general accounting, natural resource accounting information and other information at firm-level,
- Considering the physical and financial data related to the environment within the scope of environmental accounting,

Bartolomeo et al. (2000) stated *"Environmental accounting provides information inwardly in the pricing decisions, cost control and capital budgeting; whereas it also provides data outwardly for the public and the financial community about public disclosure reports related to the environment"*

Businesses is required to report the physical and financial information related to the environment in which it operates and natural resources it uses to the public in a separate statement in the accounting information system. The potential harm that business activities may give to the environment with financial aspects and the expenditure and initiatives could prevent these harms should be full disclosure to the public by enterprises under the principle of public disclosure.

Environmental accounting helps to make decisions on identifying those responsible for the pollution stemming from commercial activities and the estimated environmental effects and expenditures. In addition, environmental accounting produces information needed in planning to reduce environmental expenditures and different consumption structures (Bailey and Soyka, 1996). This is associated with physical units / activities of the enterprise as well as monetary aspect (Lintott, 1999). Moreover, environmental accounting helps in allocation resource for environmental costs, cost measurement, integration of business decisions and providing information to the external environment (Stanko, Brogan and Alexander, 2006).

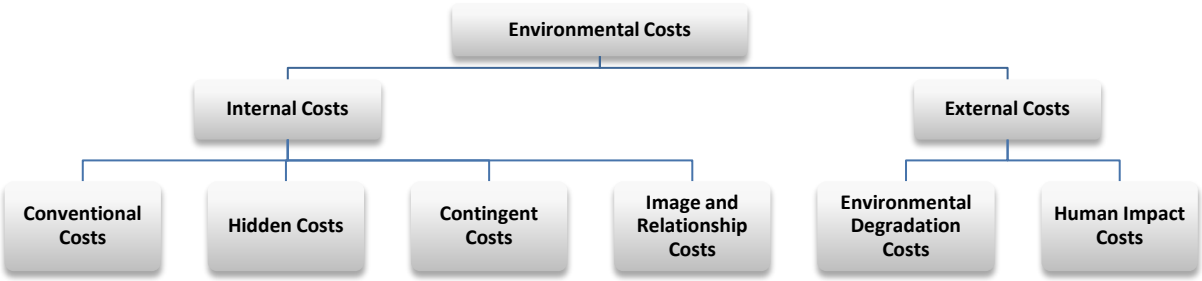
Environmental Costs

Today, it is seen that society's environmental awareness developed depending on the environmental disasters (Masanet and Llodra, 2006). Businesses have to effort in regard to the creation of environmental awareness and protection of the environment as well as individuals. In this respect, environmental accounting can be described as *"a tool used to identify and measure environmental costs for the provision of adequate environmental performance."* (Todae et al., 2011).

U.S. environmental protection agency mainly divides environmental costs into two. First, they are the internal costs affect the businesses directly and they can interfere with them. Secondly, they are the external costs that businesses are not responsible and they cannot interfere with them. This definition can be expressed as the following general headings (Todae, 2011);

[1] US EPA – United States Environmental Protection Agency

Exhibit-4-1: Types of Environmental Costs



Source: Todae et al. 2011, pp.653

Traditional costs are the costs arising from machinery and equipment, raw materials and consumer goods.

Hidden costs represent the indirect environmental costs or the dependent costs which may occur in the future. Within the scope of hidden costs, environmental costs resulting from legal obligations and voluntary actions are included. These costs are the costs that arise during the execution of the activities of a process, system or facility. Many businesses assess these costs as an expense in the period, and do not give the necessary importance to these costs in their business decisions and daily activities (EPA, 1995: Todae, 2011).

Dependent costs represent the costs may arise in the future depending on the environmental effects. For example, penalties to be paid for the oil spills as caused by various accidents and expenses related to the solution of environmental damage caused are the dependent costs (EPA, 1995: Todae, 2011).

Image and relationship costs (Public Relations) have more abstract structure than other costs. These costs are more difficult to measure compared to other environmental costs as they are abstract structured costs based on the subjective perception of managers, customers, employees, public and the governments. Examples of these costs are the costs associated with annual environmental reports, relations with the local population and environmental activities carried out on a voluntary basis (EPA, 1995: Todae, 2011).

External costs, the costs that businesses are not directly responsible but arise from the activities which have adverse effects on the environment. Activities that give rise to these negative consequences are the activities that cannot be prevented by law. In addition, to measure the real values of the external costs is difficult. However, some businesses are trying to take these costs as an item of costs within the environmental accounting systems (Todae, 2011). According to the U.S. Environmental Protection Agency, the environmental cost types are shown in Table: 4-2.

Potential hidden costs, represent the environmental costs that cannot be foreseen by managers. These costs are the environmental costs due to legal obligations, voluntary actions and the activities of enterprises. Although these costs are classified as overhead costs or research and development costs, some of the costs may be overlooked before operating as business managers focus on the costs of the investments to be done (EPA, 1995).

The resulting environmental costs may be subject to different classifications according to their occurrence. While some of the environmental costs emerge as a result of the activities carried out for the purpose of environmental protection and providing sustainability, others occur as a result of the use of resources in production activities. In addition, some of the environmental costs emerge as a result of environmental pollution caused by enterprises. In this context, environmental costs can be examined under three headings: prevention costs, operating costs and affect costs (Çelik, 2008).

Prevention costs are the costs incurred in the process of design, production, usage and destruction stages of the product in order to protect the environment and minimize the environment damage (Çelik, 2008). Costs incurred in the life cycle of the product;

- Environmental planning costs,
- Environmental harmonization costs in product design,
- Recycling costs,
- Eco-friendly packaging costs,
- Environmental management costs, waste control, elimination or treatment costs are within the scope of prevention costs. These costs are the costs that can be determined in accordance with the decisions of the administration.

Operating costs can be defined as the price for public natural resources benefited while operating activities. The use of natural resources such as air, water, soil, and minerals are kinds of these costs. Businesses may not be required to pay a fee for the operating costs arise from the use of natural resources if environmental damage that the public suffered as a result of the use of these assets is below the limits permitted by law (Çelik, 2008).

Affect costs are the costs related to environmental damage caused by the failure of the previous phases. These cost elements are defined as reduction in fauna and flora and the losses caused by waste released into air, water and the soil (Çelik, 2008). Measures taken after the pollution of the environment and natural damage are not effective and also lead to huge economic losses. In this context, environmental problems need to be managed before their occurrence (Kırımhan, 2005:113).

Table-4-2: Examples of Environmental Costs

POTENTIALLY HIDDEN COSTS		
Regulatory	**Upfront**	**VOLUNTARY (Beyond Compliance)**
Notification	Site Studies	Community relations/outreach
Reporting	Site Preparations	Monitoring/Testing
Monitoring/Testing	Permitting	Training
Studies/modeling	R&D	Audits
Remediation	Engineering and Procurement	Qualifying Suppliers
Recordkeeping	Installation	Reports (e.g., Annual Env. Reports)
Plans		Insurance
Training	**Conventional Costs**	Planning
Inspections	Capital Equipment	Feasibility Studies
Manifesting	Materials	Remediation
Labeling	Labor	Recycling
Preparedness	Supplies	Environmental Studies
Protective Equipment	Utilities	R&D
Medical surveillance	Structures	Habitat and Wetland Protection
Environmental Insurance	Salvage Value	Landscaping
Financial assurance		Other Environmental Projects
Pollution Control	**Back-End**	Financial support to environmental groups and/or Researchers
Spill Response	Closure/Decommissioning	
Stormwater Management	Disposal of Inventory	
Waste Management	Post-closure Care	
Taxes/Fees	Site Survey	
CONTINGENT COSTS		
Future Compliance Costs	Remediation	Legal Expenses
Penalties/Fines	Property Damage	Natural Resource Damages
Response to Future Releases	Personal Injury Damage	Economic Loss Damages
IMAGE AND RELATIONSHIP COSTS		
Corporate Image	Relationship with Professional Staff	Relationship with Lenders
Relationship with Customers	Relationship with Workers	Relationship with Host Communities
Relationship with Investors	Relationship with Suppliers	Relationship with Regulators
Relationship with Insurers		

Source: US EPA, 1995, pp.9

Some of the environmental costs are not paid and / or not taken into account by businesses. For this reason, these costs are not included in financial reports and records. For example, businesses do not take into account the noise they emitted to the environment and the harm they give to animals and plants. Another example is the use of underground water free of charge and to release it to environment. However, enterprises should calculate the damages in detail caused by the usage of resources and releasing them to the nature, should make cost analysis and submit them in their reports (Haftacı and Soylu, 2008).

The activities done to minimize environmental risks likely to emerge as a result of operating activities and to protect the environment and the costs associated with them can lead to structural and financial changes on businesses. These changes are (Epstein, 1996);

- Reducing costs with re-designing of the production process,
- Reducing costs with a change of product design,
- Price increases,
- A low price can be accepted at the first stage to determine the entire cost and price,
- To develop a launch strategy for the adoption of the product on the market.

When businesses made a choice considering the environmental impact to purchase an asset, how to account for cost differences arising is covered by environmental accounting. In this context, the costs incurred related to the environment is calculated in detail and the financial effects are shown in financial reports. Environmental risks which are non-financial must be shown in detail in operating / environmental reports and in the notes of the financial report (Haftacı and Soylu, 2008).

Environmental Management Accounting (EMA)

Environmental management in enterprises has emerged as a data entry in the traditional management accounting. Desire for a better understanding of finance costs relating to the environment raised interest in the subject. Encouraging point in this development is that the effects of environmental factors on the profitability and financial position (Bartolomeo et al., 2000).

An organization should determine what its environmental aspects within the scope of its environmental management system by taking into account inputs and outputs (wanted or unwanted) related to currently being carried out or past activities, products and services, planned or new developments and new or modified activities, products and services. This process should take into account normal and abnormal operating conditions, including logically foreseeable emergency situations and decommissioning and commissioning requirements (ISO 14001, 2005).

There is no generally accepted definition of environmental management accounting (EMA). Based on the definition of IFAC[2] *"EMA is the management of the environmental and economic performance in the developing techniques for acceptable environmental accounting system and implementation process."* Some add reporting and auditing as well to this definition (EPA, 1995).

In addition to definition of IFAC, the United Nations Expert Working Group defines EMA as *"the process of identifying, gathering, analyzing and using information to make inward decisions"*. Information is used in the process divided into two groups (IFAC, 2005). These are:

- physical information associated with the usage, circulation and release of energy, water, and other materials (waste) and
- The costs associated with the environment and financial information about recycling and protection.

The traditional accounting system is inadequate on environmental issues. This inadequacy is that environmental costs arising from operating activities do not examined separately in the traditional accounting system and are shown in semester / production costs. This situation causes not be aware of business managers about environmental costs and not being able to reach sufficient knowledge to manage these costs. Because they are not measured as necessary, business managers cannot effectively reduce these costs (Erkuş and Ateş, 2008:270).

Similarly, a study conducted by management accountants in the United States, reveals that business decisions do not take environmental costs into consideration enough. Giving a cost list to the participants in the study, they are asked which costs they consider when investing and the results indicated that environmental costs such as waste water, time the staff spent on the environment and penalties and so on were at lower ranks (Erkuş and Ateş, 2008:270).

Environmental Management Accounting: Application, Utility and User Area

EMA whose overall objective is to produce environmental information, on the basis of the information produced it tries to explain the interaction between human beings and the environment. To limit the production of environmental information at the macro level can reduce the contribution of environmental decisions to be

[2] International Federation of Accountants

made at the micro level and may not provide expected environmental benefits in improving the environmental life quality. For this reason, environmental accounting should be capable of producing the necessary useful information not only at the macro level but also at micro level (Kırlıoğlu and Can, 2004). When we consider the environmental relationships at micro level, businesses are an important part of this interaction. To be successful at the micro level on environmental awareness, governments should create a national policy about environmental awareness and there must be co-operation and harmony with businesses (Çakar, 2007).

Environmental management accounting focuses on the process of measuring, verification, pricing and costing of consumption of the assets such as energy, raw materials, waste and so on. Accordingly, the these assets are identified in accounting system and activities carried out to reduce the harm they give to the environment and costs it caused (Masanet and Llodra, 2006).

Environmental financial accounting focuses on both reporting costs related to the activities of environmental obligations and other environmental liabilities and the presentation of information to those interested in non-business environmental financial information. Environmental management accounting as a part of management accounting focuses on giving information to decision-makers within the company about the raw materials, energy flow and so on. In this case, environmental financial accounting represents the outward face of business and environmental management accounting represents the inward face (Xiaomei, 2004: Wilmshurt and Frost, 2001). In other words, environmental financial accounting refers to the internal costs while management accounting environment refers to the external costs.

Environmental accounting which is sub-branch of environmental management accounting consists of four steps. The first step is the creation of business policies and strategies based on the legal requirements and environmental policies needed for the company image. The second step is the addition of environmental costs to production processes of the enterprise and reporting these costs. Third is to perform outward looking environmental reporting to be able to control the proficiency and scope level of environmental practices. The last step is to provide the technical and legal academic support for environment and to educate students who will become practitioners of environmental accounting in the future (Yakhou and Dorweiler, 2004). As well as the academic support carried out, businesses will provide some contributions to the environmental issues and will get some benefits through environmental accounting policies they followed. These are:

- Resource efficiency improvement and management of environmental costs,
- Ensuring compliance with environmental legislation,
- Reduction of environmental costs,
- More knowledge-based decision-making,
- Revealing opportunities,
- Pricing the products better,
- Internal and external reporting assistance,
- To increase the reputation/credibility of the business,
- Employee loyalty and attracting staff,
- The production of social benefits (Erkuş and Ateş, 2008),
- Determination of environmental costs and better management/ monitoring of the problems related to the environment,
- The production of knowledge needed for the environmental impacts of investments (Carrera and Iannuzzi, 1998).

Due to the EMA's focus on environmental issues, in particular it contributes to business management. Eco-friendly product / production, eco-friendly product or service design and environmental management systems can be seen as examples of environmental issues that environmental management accounting focuses on. Similar to the manner, the information provided by environmental management accounting is used in outward reporting. For this reason, EMA is not just a one-sided environmental management tool. EMA is a set of general principles and approaches, providing basic information for the success of many environmental management activities. Since the effects of environmental issues in decision making have had a growing trend, EMA has become more important in both environmental management decisions and in all other government activities (IFAC, 2005). At this point, EMA's application areas in business management can be listed as follows (UNSD, 2001):

- Valuation of the annual environmental costs / expenditure,
- Product pricing,
- Capital budgeting,
- Assessment of investment alternatives, accounting the amount,
- Accounting costs and benefits of environmental projects,

- Design and implementation of environmental management systems,
- Environmental performance measurement and benchmarking,
- Identification of performance targets,
- Declaration of environmental expenditures, investments and liabilities,
- Preparation of environmental reports or sustainability reports,
- The reporting of other environmental information for local authorities and statistical agencies.

Environmental management accounting has a large number of usage areas and benefits. In general they can be expressed under three headings: (IFAC, 2005):

Compatibility: EMA supports the cost-effectiveness of environmental protection through ensuring compliance of business with environmental policies, laws and regulations.

Eco-efficiency: EMA supports the use of energy, water and resources more efficiently and effectively in the activities within the business and in final products by reducing operating costs at the same time.

Strategic Status: EMA supports to guarantee the long-term strategic status of the enterprise. In addition, it is used in the measurement of cost-effectiveness of the business and in the evaluation of environmental interest programs.

Conclusion

Businesses have a responsibility to concern and fulfil towards its employees, stakeholders and public while carrying out their activities due to its objectives. Environment has an important position within the scope of these responsibilities. As a requirement of sustainability, businesses using environment while carrying out its activities should think about future generations whereas they meet the needs of today's consumers and they must perform their activities on this perspective.

The environment is also important as well as the presence of production factors in order to meet continuity of business and demands of consumers. In sustainability management of the environment is a significant subject and environmental damage should be reduced to a minimum level. It is possible to define and measure environmental costs of activities to be done during the period and to minimize the potential environmental costs via environmental management accounting.

Environmental management accounting requires planning environmental impacts of main and other activities carried out during the period and the management of costs emerge. In addition, protection of the ecological structure of the environment in which businesses operate and sustainability can be provided by environmental management accounting.

In order to implement environmental management accounting successfully and to manage environmental costs, it is required to establish an independent environmental department under business and to ensure effective communication with other departments. Main accounts and subsidiary accounts should be opened to monitor the environmental costs just as the accounts monitor marketing, management, R & D expenses and they must take place in the uniform chart of accounts functionally. In addition, the environmental effects of operating results related to the sector of businesses should be put forward. The environmental problems will arise depending on investment projects planned for the future and solution plans with the environmental reports also must be presented. Thus, sufficient information can be presented to the public about the events that may emerge from the non-financial environmental risks which may affect the business and its future as well as financial position of business. So that the public will be able to have enough knowledge about measurement and evaluation of current and future risks of the business.

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Intelligent Data Mining For Automatic Face Recognition

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Abstract: The advancement in computer science and information technology is one of the most important characteristics of the century. One of the important consequences of this advancement is the availability of huge number of automated databases which are waiting to be exploited. This exploitation will lead to knowledge discovery which will help the decision making processes in many fields. In this paper a knowledge discovery, data mining, artificial intelligent technique called Logical Analysis of Data (LAD) is introduced and applied to the well know problem of face recognition. Knowledge discovered in the form of patterns is saved and then used in a machine learning system in order to identify the already learned faces, and to distinguish them from unknown faces. The results show that LAD is promising approach to pattern recognition.

Key words: Data mining, knowledge discovery, artificial intelligence, face recognition, Logical Analysis of Data.

Introduction

The increase in the number of databases in many field create new challenges to researchers in different field. It is reported in (Witten, Frank, & Hall, 2011) that the amount of stored databases doubles every 20 months. It is difficult or even impossible to justify the storage of this amount of data in any quantitative sense. Instead, the important information should be extracted from the data. This operation is called knowledge discovery since there is usually certain amount of useful information that is potentially important in each database and need to be discovered.

Data mining is defined as the process of automatic exploration and extraction of the knowledge from the data (Gorunescu, 2011). The idea is to build computer programs that refine the databases automatically. Among the extracted patterns, some will be trivial and non-interesting, others, on the other hand, will general and can contribute to accurate prediction of future data (Ryoo & Jang, 2009). The patterns discovered must be meaningful and have some advantage in an economic sense. From economical point of view, one of the most important requirements for the patterns is the comprehensiveness (interpretability). Some patterns are comprehensible (also called transparent or interpretable or structural) while some of them are incomprehensible (called black box patterns). From the performance point of view, both of them can make good predictions (Bishop, 2006). The advantage of using comprehensible patterns is their structural representation that can be examined to inform on future events. In other words, they can help the analyst as well the decision maker to explain something about the data in an explicit way (Bores et al., 2000).

Data mining is a topic of increasing interests that involves learning in a practical sense. Researches supported by international agencies, industry and academia are focusing on designing more effective and intelligent data mining techniques (Bozdogan, 2003).

Machine learning provides the technical basis of data mining (machine learning is the technology for mining knowledge from data) (Bishop, 2006). It relies on the availability of data and draw on learning strategies from the area of computational intelligence, statistical pattern classification, and others (Bishop, 2006). The word learning means that these techniques learn from the changes appearing in the data in a way that improves their performance in the future. Thus learning is tied to performance enhancement. Based on this learning process, the learning techniques can be employed to map data into decision model in order to produce predicting output from new data. The decision model is called classifier (Bishop, 2006).

There are two approaches for machine learning, supervised learning and unsupervised learning (Bishop, 2006). In supervised learning, the purpose is to infer the decision model from labeled data. In unsupervised learning, the learning technique is fed with only unlabeled objects (there is no a priori label).

Logical analysis of data (LAD) is a supervised data mining methodology. It was introduced by the group of researchers of RUTCOR at Rutgers University in USA (Bores, et al., 2000). Logical Analysis of Data (LAD) is a combinatorial and optimization based method used in many applications such as oil exploration, detection and prediction of some diseases (Bores, et al., 2000). LAD was introduced to the field of condition based maintenance (CBM) as a new approach for automatic diagnosis of faults in rolling bearings (Mortada, Yacout, & Lakis, 2011). LAD was also able to reproduce human expertise in detecting and analyzing the phenomenon of rogue components in airplanes (Mortada, Carroll, Yacout, & Lakis, 2009). In the airlines industry, LAD was applied to estimate the overbooking level by predicting the show rates of passengers (Dupuis, Gamache, & Pagé, 2012). LAD is applied to develop credit risk rating models for evaluating the credit quality of banks (Hammer, Kogan, & Lejeune, 2012).

One of the advantages of LAD over many data mining techniques is the interpretability (transparency) of its patterns. In other words, LAD can generate patterns that can be easily interpreted and translated into rules which are beneficial to the decision makers (Bores, et al., 2000). LAD is not depending on any statistical analysis; this is another important advantage that makes it capable of dealing with the data that are highly correlated, without the need to satisfy any statistical assumptions.

The main objective of this paper is to apply LAD to the field of face recognition. The aim here is to build a single multi-class decision model that recognizes the images of different objects. This model can effectively deal with multiple changes in facial expression. The paper is organized as follows: The multi-class LAD decision making approach proposed here is presented in the next section. In section 3, the experimental results obtained by using LAD with a known dataset that is employed to train and test different face recognition techniques. Section 4 discusses these results while section 5 concludes the paper.

Logical Analysis of Data

LAD is a combinatorial and optimization method that evolved as an effective classification technique that relies on extracting patterns from binarized data in order to formulate decision rules that classify data into more than one class (Bores, et al., 2000). LAD was used as a Boolean technique to identify the causes of a certain event through investigating a set of factors representing all the possible causes of that event (Crama, Hammer, & Ibaraki, 1988). It is used to extract knowledge from a dataset consisting of observations that can be represented as binary or numerical vectors. Each vector is composed of the values of certain characteristic features). Originally, LAD was used as two-class classification technique (dichotomizer) (Bores, et al., 2000). The observations are classified as either positive Ω^+or negative Ω^- where $\Omega^+$and Ω^- are the sets of positive and negative observations, respectively in the training data setΩ. A specific characteristic of LAD is the extraction of a set of patterns which are the interactions between features for either positive or negative observations in the dataset. Accordingly, LAD can be used as pattern-based classifier of new observations that are not included in the original dataset (Bores, et al., 2000).

Like the conventional two-class LAD, the multi-class LAD decision making approach composed of three steps: data binarization, pattern generation, and theory formation. In what follows, we present the steps of the methodology of LAD which generates an entire set of patterns for a single dichotomy for the two classes. Then we explain how to generate a set of multi-class patterns that can be used to create the decision model in the theory formation step of the multi-class LAD approach.

Data binarization

The binarization procedure in (Mortada, et al., 2011) is presented in this paper, as the first step in LAD methodology. The data binarization step involves the transformation of numerical data to binary data using a binarization technique that transforms each numerical feature into a set of binary attributes. The binarization of a continuous numerical feature A, and the number of binary attributes needed to replace it are dependent on the number of distinct values of A in the training data set. The binarization procedure starts by ranking, in ascending order, all the distinct values of the numerical feature A as follows:

$$u_A^{(1)} < u_A^{(2)} < \cdots < u_A^{(M)} \qquad (M \leq N)$$

Where M is the total number of distinct values of numerical feature A and N is the total number of observations.

Then a cut-point $\alpha_{A,j}$ is introduced between each pair of values that belong to different classes. The cut-point is calculated by averaging the two values as:

$$\alpha_{A,j} = (u_A^{(i)} + u_A^{(i+1)})/2 \quad (1)$$

Where the superscript (i) refers to the order of the distinct value of A and j refers to a specific feature, $u_A^{(i)} \in \Omega^+$ and $u_A^{(i+1)} \in \Omega^-$ and vice versa. A binary attribute b is then formed from each cut-point. Each cut-point $\alpha_{A,j}$ has a corresponding binary attribute $b_{\alpha_{A,j}}$ with is defined as:

$$b_{\alpha_{A,j}} = \begin{cases} 1 & if \quad u_A \geq \alpha_{A,j} \\ 0 & if \quad u_A < \alpha_{A,j} \end{cases} \quad (2)$$

As a result of this binarization process, the number of binary attributes that make up the binarized training set is equal to the number of cut-points generated for each numerical feature in the training data set.

Pattern generation

Patterns generation is the key building block in LAD decision model. This step is essential in identifying the positive and negative patterns from the binarized dataset of positive and negative observations. The accuracy of LAD decision model depends on the type of generated patterns (Ryoo & Jang, 2009).

i. Definitions and characteristics of Patterns

A positive (negative) *pattern* is defined as an elementary conjunction of some of literals that is true for at least one positive (negative) observation and false for all negative (positive) observations in the training data set (Bores, et al., 2000). A literal is a Boolean variable x or its negation $\bar{x}$. Each binary attribute b_j in the training set can be represented in a pattern by a literal x_j or its negation $\bar{x}_j$, where x_j is used for $b_j = 1$ and $\bar{x}_j$ for $b_j = 0$. The degree d of a pattern indicates the number of literals used in its definition. A pattern is said to *cover* a certain observation if it is true for that particular observation (Bores, et al., 2000). The set of observations covered by the pattern P is denoted as $Cov(P)$. A high degree pattern is more likely to cover small proportion of observations, while pattern with a low degree is more likely to have higher coverage (Ryoo & Jang, 2009). In the testing dataset, misclassified observations are results of generating high degree patterns while unclassified observations are results of low degree patterns (Ryoo & Jang, 2009).

ii. Pattern generation approaches

Patterns are the corner stones in LAD methodology. In the literature, there are three common approaches for pattern generation: enumeration based approaches (Bores, et al., 2000; Hammer, Kogan, Simeone, & Szedmák, 2004), heuristic approaches (Hammer & Bonates, 2006), and Mixed 0-1 Integer and Linear Programming (MILP) based methods (Mortada, et al., 2011; Ryoo & Jang, 2009).

The MILP based approaches proposed in (Ryoo & Jang, 2009) can generate useful patterns that are optimal with respect to various selection preferences (simplicity, selectivity, and evidential (Hammer, et al., 2004)). The procedure for generating one positive (negative) pattern is formulated as an MILP maximization problem. It can generate strong prime patterns which make LAD classifier generalize better on new observations. The experimentations in that paper show that the generated strong prime patterns can reduce the number of unclassified observations (Ryoo & Jang, 2009). The approach can also generate strong spanned patterns and hence the classifier is likely to be robust to noisy observations (reduce the number of misclassified observations) (Ryoo & Jang, 2009). The MILP based method proposed in (Mortada, et al., 2011) is a modified version of the approach introduced in (Mortada, et al., 2011). The modification aims at maximizing the diversity of patterns generated from the same training data set without a significant increase in training time, thus increases the classification power in the two-class problems.

The generation of positive and negative patterns in *two-class LAD* model is extended to *multi-class LAD* decision model. An extension to multi-class applications that involves the modification of the architecture of *LAD* is proposed in (Mortada, Yacout, & Lakis, 2010). The proposed method has the advantage that it generates a less complex decision model which has a better execution time (Mortada, et al., 2010). In that paper, the procedure for pattern generation in multiclass dataset starts by creating empty sets of patterns P_{ij} for each pair of classes (c_i, c_j) where $, j \in \{1,2,..K\}$ $i \neq j$, and K is the total number of classes. The sets P_{ij} are generated through multiple solutions of the MILP based on the single pattern generation algorithm presented in (Mortada, et al., 2011).

Theory formation

The final step in the *LAD* decision model is the theory formation. For the conventional two-class LAD decision model, the generated positive and negative patterns are selected and then used to create a model called the discriminant function that generates a score ranging between -1 and 1. The discriminant function used in (Mortada, et al., 2010) generates a score for each class and therefore the tested observation belongs to the class with the highest score.

Experimental Results

In this section, we explain how multi-class LAD decision model can be used in the field of face recognition. A description of the pre-processing mechanisms used here for extracting features from the images of one of the face dataset in the field is presented. The performance of *multi-class LAD* decision model is compared with other common face recognition techniques.

Japanese Female Facial Expression (JAFFE) database

i. Pre-processing and features extraction

The results presented in this section were all performed on *Japanese Female Facial Expression (JAFFE)* database(Lyons, Akamatsu, Kamachi, Gyoba, & Budynek, 1998). The database contains 203 images of different facial expressions. The images are taken for 10 Japanese female models. Each image is represented as 256×256 pixels. The pre-processing of the images is performed by resizing the images to *100×100* pixels. In order to evaluate the accuracy of the model, we have applied the standard 10-fold cross validation method (Witten, et al., 2011). The *Eigenfaces* and *FisherFaces* are extracted from the training images (Belhumeur, Hespanha, & Kriegman, 1997). The proposed model is compared to some common classification techniques: instant based (IB), Bayesian, support vector machines (SVM), multi-layer perceptron-neural network (MLP-NN) (Witten, et al., 2011). The algorithms for such techniques are implemented in the publicly available Weka software package (Bouckaert et al., 2010).

ii. Performance comparison

The performance comparison between *multi-class LAD* and these classification techniques is shown in Table 1 and Table 2. Table 1 shows that the accuracy is enhanced when the number of *Eigenfaces* increased. In Table 2, the performance is shown for the *FisherFaces*. The objective is to study the impact of changing the number of extracted feature (*Eigenfaces* and *FisherFaces*) on the *LAD* classification accuracy.

Table 1: Eigenfaces with IB, Bayesian, SVM, MLP, and multi-class LAD on JAFFE database

Number of Eigenfaces	1	2	3	5	10	20	40
Minimal Distance classifier (IB)	31.7073	80.4878	85.3659	95.122	97.561	97.561	100
K-Nearst Neighbor (K=5)	41.4634	85.3659	75.6098	85.3659	95.122	95.122	97.561
Multi-Layer Perceptron (MLP)	46.3415	80.4878	85.3659	95.122	97.561	**100**	**100**
SVM with Radial Basis Function	41.4634	73.1707	56.0976	51.2195	34.1463	41.4634	51.2195
Bayesian (Maximum Postorior; MAP)	43.9024	85.3699	85.3659	92.6829	95.122	97.561	97.561
Multi-class LAD	48.7805	85.3659	85.3659	87.8049	95.122	97.561	**100**

Table 2: FisherFaces with IB, Bayesian, SVM, MLP, and multi-class LAD on JAFFE database

Number of Fisherfaces	1	2	3	5	9
Minimal Distance classifier (IB)	70.7317	97.561	**100**	**100**	**100**
K-Nearst Neighbor (K=5)	73.1707	97.561	**100**	**100**	**100**
Multi-Layer Perceptron (MLP)	73.1707	95.122	**100**	**100**	**100**
SVM with Radial Basis Function	68.2927	97.561	**100**	**100**	**100**
Bayesian (Maximum Postorior; MAP)	70.7317	95.122	**100**	**100**	**100**
Multi-class LAD	**80.4878**	**100**	**100**	**100**	**100**

The software cbmLAD is implemented in C++ programming language at École Polytechnique de Montréal, Canada (Salamanca, 2008) is adapted to deal with the special application of LAD to face recognition. The multi-class LAD decision model is trained and tested using the training images of the dataset mentioned above.

Conclusions

This paper aims at exploring an intelligent face recognition technique that employs a database from face recognition literature. *Eigenfaces* and *Fisherfaces* are applied to extract the relevant information from the images which are important for recognition. We described how to propose the *multi-class LAD* classifier as a decision model for the purpose of face recognition. The study shows how *multi-class LAD* and can be utilized and how it might be useful compared to other face recognition techniques. As a final conclusion, the *multi-class LAD* is a promising approach in the field of pattern classification and image processing in particular when it is used with efficient approaches such as *Fisherfaces* that guarantees high discriminative power among the classes. This motivates us to apply *multi-class LAD* as an image classification technique in the context of condition based maintenance in the future.

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Lean Service and Application of MRI-Tomography Imaging Center

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Abstract: In this study, Magnetic Resonance (MRI) and Tomography Imaging Center of an Education and Research hospital was investigated from a system development point of view, and processes causing waste were identified. During analysis phase, it was found that waste-causing processes arise from waiting of patients due to deficiencies of the appointment system. Starting with the lean management philosophy and using tools and techniques of lean service notion, these processes were redesigned and waste was prevented by also taking the resistance and critical success factors encountered during lean application process into consideration. For this purpose, differences of incoming patients, types of operations, preparation periods and cycle times were analyzed and a new appointment model was proposed.

Key Words: Lean Management Systems, Lean Service, Lean Healthcare, MRI-Tomography Imaging Center

Introduction

In the recent years, organizations attach as much importance to service and customer satisfaction as they attach to profitability, and they benefit from various techniques, technologies and points of view in order to meet expectations of dynamic demand, short operation/delivery period, high quality and low cost and to maintain their existence. Lean production and Lean Thinking in this regard are deemed as a nearly indispensable approach. Lean Thinking is a way designed to define the value, to line up the actions that create value in a manner that will give the best result, to implement these activities uninterruptedly and in an increasingly efficient fashion. In brief, Lean Thinking is lean, since it shows the way to derive more with increasingly lower efforts, less equipment, less time and less space, and thereby it converges more to the exact wishes of the customer. (Womack, Jones, 2003). Today, service-oriented sectors gain more significance and growing enterprises aim at profit maximization by eliminating waste. Lean Thinking essentially focuses on defining activities that do not create value in the services and production sectors and removing waste (Womack, 1990).

Lean service is use of basic principles of lean production in the services sector. Lean production philosophy that provided successful results in the manufacturing industry has started to be used in the service sectors in the recent years. Application of Lean Thinking is new and being adopted by health, logistics and enterprises that sell fast services at the first stage (Efe, 2011).

Lean Management in the Hospitals

Existence of organizations, their survival and boosting of their market shares in today's competitive conditions is possible by responding to customer demands in the fastest and accurate way possible, above everything else. Hospitals, which carry out activities on humans that add value, cannot always respond to the demands of patients or cannot respond immediately and this gives rise to plenty of waiting time. Major reasons of these waiting times are bottlenecks and waste in the system. When one considers that people expecting service from hospitals are mostly patients, it is natural that they easily get dissatisfied as they do not have the endurance and time to wait. For these reasons, bottlenecks in the system should be quickly fixed, efficiency of so expensive resources should be increased and waste should be eliminated. Here, lean tools and techniques come to the help of hospitals, which are used in lean production but today receive interest in the services sectors as well. In our country, use of Lean Thinking philosophy in the service sectors (especially the health sector) is not so common, whereas in the world, especially in the United States, the years when applicability of Lean Thinking to the health sector was discussed are left behind and many hospitals implemented lean transformation successfully and obtained positive results. That is because, Lean Health can turn from a goal into reality owing to the need to do "more work" with "less resources" in parallel to the economic change in the world and increased focus on raising safety and quality along with performance (Graban, 2008).

It may be useful to have a common terminology in identifying waste. 7 types of waste defined for the production sector can be used as a useful framework in identifying the waste in the hospitals. However, since hospitals involve processes that focus on humans, human potential is added as an eighth type of waste (Melton, 2005). There are eight types of waste defined for hospitals. These are:

- ✓ Defects
- ✓ Overproduction
- ✓ Unnecessary Movement of Materials
- ✓ Waiting
- ✓ Excessive Stock
- ✓ Unnecessary Movement of People
- ✓ Over processing
- ✓ Human Potential

Materials and Method

Site of the study is the MRI and Tomography imaging center of an Education and Research Hospital. The number of patients is high, since the imaging center offers services in a state hospital, which is a full-fledged hospital. The center offers services 7/24 in three shifts of 8 hours. Full service flow of patients that come to the imaging center, from registration to the discharge, was analyzed. During analysis, problems were identified, and reasons of the problems were investigated by going down to the root causes. A system that would provide a solution to these problems was designed and application results were discussed.

Identification of the problems

Process of identifying and resolving problems is tough job due to complexity, difficulty of choosing alternatives, ambiguity and the risk it involves. Due to these difficulties, best way to solve a complex problem is to use an effective decision-making process (Engin, 2005). At this stage, method of face to face meeting with the employees and patients was used. Work flow maps were studied, and upper management, employees and patients were met to identify the problems. But, the biggest problem seen was waiting of the patients. Patients had to wait a lot for the operation even if they come at the time of appointment, which caused dissatisfaction and problems.

Waiting time can in general be defined as the time during which no operation is done. It is easy to identify a lack of action as waste, but it is difficult to differentiate waiting times. Patients usually wait in the clinics due to bad work flow or bad programming. For patients, waiting time is the time they waited to reach the step that adds value in the patient tour. In a hospital, it is not only patients who wait, at the same time many materials wait during much of the time instead of being used in value-adding works. The reason for the waiting times is that work is done aggregately within the service and that the workflow does not comply with the first in-first out rule (Graban, 2008). In Table 1, appointments in a period of one month is investigated and average delays (average waiting time of the last patient) can be seen. Appointments given by the center during a one month time was investigated and waiting time of the last patient at the end of the day was calculated using these appointment lists.

Table 1. Monthly appointment delay periods

Delay Period (Hours)	Number of days	Percentage (%)
1	4	13
1-3	8	27
3-5	16	53
> 5	2	7

As seen in the table, last patient waits for 1 hour during 4 days, for 3 hours during 8 days, for 5 hours during 16 days and for more than 5 hours during 2 days. When average of these figures is taken, daily average waiting time is 188 minutes.

Identifying the reasons for the problems

In order to identify the reasons for waiting problems of patients in the imaging center, Fish Bone Diagram (Cause-Effect Analysis) used in the decision-making and problem-solving stages of Lean Production applications was used.

Fish bone diagram

A fish bone diagram shows the relationship between causes and effects. In general, it is used to reduce a problem to a few basic problems and focus on these potential basic problems. Fish bone diagram was first used in 1953 by Professor Kaoru Ishikawa in the quality applications in Japan (Şengül, 1997). In Figure 1, one can see the fish bone diagram prepared to find a solution to the question "Why do patients wait for a long time?" with the employees of the imaging center and to go down to root causes of this problem.

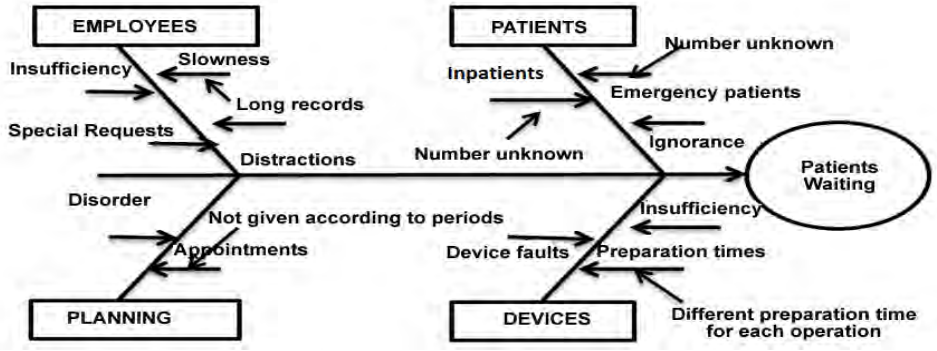

Figure 1. Fish Bone Diagram

According to the fishbone diagram created, reasons for waiting of patients are elongation of registration times, the fact that appointments are not given according to the time needed for imaging and according to the types of imaging, the fact that inpatients and emergency patients are not separated, insufficiency of number of staff, insufficiency of number of devices, the fact that patients are not sufficiently informed, special requests of the doctors, patients keeping technicians busy and lengthy preparation times. Elimination of these identified problems will contribute to lean transformation. But, trying to solve all of the problems will lead to failure to identify the root causes and allow repetition of these problems. For this reason, it should be determined solving which problems will contribute more to the lean transformation. Pareto analysis was conducted for this purpose.

Pareto analysis

This approach laid out by Italian economist Pareto in 1897 and later implemented by M. C. Lorentz was originally developed to show the income distribution. It is J. M. Duran who adapted this to quality problems by making it a significant minority-insignificant majority principle and gave it the name "Pareto analysis" (Özcan, 2001). Pareto analysis data table based on total weights, cumulative weights, percentages and cumulative percentages according to the votes of the employees is shown in Table 2.

Table 2. Pareto analysis data table

Problems	Number of votes	Percentage	Cumulative Number of Votes	Cumulative percentage
Little time reserved for emergency patients/inpatients	6	0.28571	6	0.285714
Imaging times of appointments	5	0.2381	11	0.52381
Imaging types of appointments	4	0.19048	15	0.714286
Lengthy preparation times	2	0.09524	17	0.809524
Insufficiency of number of staff	1	0.04762	18	0.857143
Insufficiency of number of devices	1	0.04762	19	0.904762
Patients insufficiently informed	1	0.04762	20	0.952381
Special requests of doctors	1	0.04762	21	1

According to the pareto diagram, there are 4 problems that differentiate from others and constitute 80 % of all problems. Making improvements in these 4 problems will affect results of lean transformation more.

Solution of Problems and Application

According to the pareto analysis, of the problems of allocating little time to emergency patients and inpatients, failure to give appointments according to imaging times and according to imaging types and length of preparation times, first three seem to arise from bad planning. Investigation was conducted to identify the root cause of the problem of lengthy preparation times, and at the end of measurements it was found that measurement times were not long but preparation operations were overly repeated. So the real problem is not the length of preparation period but repetition of preparation stages. If similarities can be identified in the preparation phase and similar works (imaging) can be done successively, waste will be minimized. Eventually, the reason behind the fact that preparation periods are lengthy in total is still the bad planning of the appointments. The solution that will eliminate all 4 identified problems is to redesign the appointment system.

Group Technology (GT) is a production philosophy based on grouping of products according to their similarities in product design and production, by making use of similarities among products. While implementing GT, similar parts are grouped in "part groups". Each group will have similar design and production features. Thus, processing of each member of a group will be similar (Özçelik, 2011). Starting with the GT definition, preparations can be grouped based on similarities. Works (imaging) that have similar preparation phases will belong to the same group. There are 40 different MRI types that can be handled in the imaging center. Preparation of the device for imaging consists of changing the coil. 40 different types are imaged using 7 different coils. Therefore, grouping works that use the same coil together will remove the process of changing the coil and reduce the preparation time. There are 7 different imaging groups. It was aimed to redesign the appointment system based on these groups. In order to avoid repetition of preparation, appointments will follow one another in the same time range during the day for MRI types within the same group, which will eliminate the need to change the coil. Also, emergency patients will be reserved time within the day, which will reduce the time arising from emergency hospitals. Patients coming to the imaging center were observed for 30 days. And when data of 30 days was analyzed, following was found.

Imaging center provides services for 24 hours. 2478 patients came for MR imaging in 30 days. Imaging is performed for 82 patients daily on average. But, average of 100 patients are given appointments, and appointments of remaining patients are cancelled by phone. Distribution of 2478 by groups is shown in Table 3.

Table 3. Group distributions

Groups	Total patients	Percentage(%)
1st Group	131	0,05
2nd Group	1119	0,45
3rd Group	384	0,15
4th Group	624	0,25
5th Group	189	0,08
6th Group	15	0,01
7th Group	16	0,01

After analyzing the number of incoming patients by group, in order to avoid waiting resulting from emergency patients, incoming emergency patients and the group of these emergency patients were investigated. During 30 days 148 emergency patients/inpatients came. 58 % of these emergency patients belong to 4th group, 24 % belong to 2nd group, 10 % belong to 5th group and 6 % belong to 3rd group. No emergency patient came for 1st, 6th and 7th groups. Distribution of emergency patients by group is as follows: emergency patients constitute 3.2% of 2nd group, 2.3 % of 3rd group, 13.7 % of 4th group and 7.9 % of 5th group. No emergency patient came for 1st, 6th and 7th groups. Average cycle time for each group was calculated. These periods are 17 minutes for 1st group, 14 minutes for 2nd group, 20 minutes for 3rd group, 11 minutes for 4th group, 19 minutes for 5th group, 15 minutes for 6th group and 25 minutes for 7th group. Daily time to be allocated by group, and number of patients on appointment and number of emergency patients calculated based on cycle times, according to the information at hand, are shown in Table 4.

Table 4. Number of patients on appointment and periods

Groups	Emergency patients	Number of patients to give appointments	Number of patients	Average service time (min)	Average preparation period (min)
1st Group	0	4	4	17	2
2nd Group	2	43	45	14	1
3rd Group	1	9	10	20	2
4th Group	5	27	32	11	2
5th Group	1	5	6	19	1
6th Group	0	1	1	15	2
7th Group	0	1	1	25	1

Since the preparation process will be performed once only, total time needed for groups:

Average set up time: T_{su}

Average service period : T_c

Average Number of Appointments: RHS

Total time for i'th group: A_i

$A_i = T_{su} + (RHS_i \times T_c)$ (1)

If total times needed for groups are calculated using the formula (1); 70 minutes is needed for 1st group, 603 minutes for 2nd group, 182 minutes for 3rd group, 299 minutes for 4th group, 96 minutes for 5th group, 17 minutes for 6th group and 26 minutes for 7th group. Total 1293 minutes should be programmed for appointments based on the number of people in the groups and remaining 147 minutes should be distributed within the day for emergency patients. This way, even if emergency patients come one after another, the patient who will wait most will wait for 147 minutes, which is a nearly impossible probability. Also, even in such case, average waiting time will be reduced from 188 minutes to 147 minutes, which means a reduction of 21.80 %.

In the current situation, number of patients who can be served daily is 82. By reducing the total preparation time, number of patients that can be served daily increased to 99, which is an increase of 20.73 %. This increase will considerably boost the profits. Even when no emergency patients come, 90 patients will be served, and this will still mean an increase of 9.95 %. But, it is almost impossible in a hospital, a dynamic system, that any process will remain unused.

Time ranges arranged by groups, when appointment schedule is arranged according to groups, is shown in Table 5.11, omitting the emergency patients. Highest number of patients comes for 2nd group. Giving the appointments for groups with the highest number of patients during daylight will allow easier communication with the doctors. For this reason, 24 hours is scheduled in the order of 2nd group, 4th group, 3rd group, 5th group, 1st group, 6th group and 7th group. If the period of 127 minutes allocated for emergency patients can be distributed according to patient numbers of groups, waste will be minimized. Appointment schedule that involve the emergency patient periods is shown in Table 5.

Table 5. Appointment time ranges

Group	Starting Time	Ending Time	Number of patients
1st Group	08:00	19:01	43
2nd Group	19:01	00:31	27
3rd Group	00:31	03:52	9
4th Group	03:52	05:39	5
5th Group	05:39	07:15	4
6th Group	07:15	07:33	1
7th Group	07:33	08:00	1

Conclusions

Present situation and situation after the redesigned appointment system are compared in Table 6.

Table 6. Comparison Data

	Current Situation	Future Situation	Comparison
Average Number of Patients	82	99	20.73 % increase
Total Preparation Period (min)	121	11	90.90 % decrease
Waiting period (min)	188	< 147	> 21.80 % decrease

With the new appointment system that is designed on the basis of reducing preparation times and waiting periods arising from emergency patients by dividing the works into groups, average number of imaging operations has increased by 20.73 %. An increase of 20.73 % will substantially boost the profits. Total preparation time has been reduced by 90.90 %. Reduction in the waiting periods will be 21.80 % at the lowest. With this new system, flow of patients improves, imaging times speed up and capacity is used in the best way. Also, cost, waste, waiting times and periods patients kept in the process are reduced, and it became possible to

do more imaging and efficiency has improved. Movement of the technicians who kept repeating the same process was minimized, which boosted their motivation.

Acknowledgements

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Numerical modeling of reinforced unpaved roads by geogrid

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Abstract: In this paper, numerical computations using Flac software are carried out to investigate the improvement of the bearing capacity of a reinforced unpaved roadway over soft clay. Placed between the subgrade and base course, or within the base course, the geosynthetic improves the performance of unpaved roads carrying channelized traffic and unpaved areas subjected to random traffic. The present study focuses on the mechanisms by which the reinforcement improves the behavior of the roadway under the effect of a static single load. The loading of the road is carried out by imposed displacement of the load contact until reaching a final displacement called rut. The pressure-displacement behavior was determined for small and large strain analysis for unpaved roads with or without reinforcement. The analysis of the distribution and the importance of tangential and normal stresses on the soil-base interface provide an explanation to the effect of the reinforcement in the improvement of the bearing capacity or what is commonly called mechanism of reinforcement. The study also highlights the effect of the stiffness and the anchorage length of the geogrid on the reinforcement.
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Key words: Modeling, unpaved road, reinforcement, large strain, geogrid.

Introduction

Geosynthetics have been used for subgrade stabilization and base course reinforcement for construction of unpaved roads since the 1970s. Placed between the subgrade and base course, or within the base course, the geosynthetic improves the performance of unpaved roads carrying channelized traffic and unpaved areas subjected to random traffic. Two types of geosynthetics are typically used in unpaved structures: geotextiles and geogrids. From the viewpoint of un-paved structure reinforcement, there is a significant difference between geogrids and geotextiles. Due to their large apertures, geogrids may interlock with base course aggregate if there is an appropriate relationship between geogrid aperture size and aggregate particle size. While the degree of interlocking depends on the relationship between geogrid aperture size and aggregate particle size, the effectiveness of interlocking depends on the in-plane stiffness of the geogrid and the stability of the geogrid ribs and junctions. As a result of interlocking, the mechanisms of unpaved structure reinforcement are different for geotextiles and geogrids (Giroud and Han, 2004a).

The review of the significant work on design methods indicates four original works that have contributed substantially to a better understanding of geosynthetics used in roadway applications (Barenberg et al., 1975; Steward et al., 1977; Giroud and Noiray, 1981; Houlsby and Jewell, 1990; Giroud and Han, 2004a and 2004b). In analytical methods, it is assumed that all the rut depth is developed in the subgrade and, the base moves as a block. This assumption is correct for all practical purposes, where the foundation soils are low resistance, and the thickness of the base layer is thin. Based on the theory of plastic equilibrium, the ultimate bearing capacity q_{lim} for soils in this condition is (for a zero base thickness):

$$q_{\lim} = (2+\pi)c \tag{1}$$

Where, c represents the cohesion of the soil. However, the localized plastic strains, which may cause, in any manner, the localized failure, begin towards the elastic limit (for a zero base thickness), given by:

$$q_{\lim} = \pi c \tag{2}$$

The failure mechanism of the clay soil, assumed at 45° in the plastic zone, is shown in Figure 1. For a given base thickness, the pressure limit on the subgrade is given by:

$$q_{\lim soil} = mN_c c_u \tag{3}$$

Where m, represents, for the authors, the bearing capacity mobilization coefficient, N_c is the bearing capacity factor of the subgrade. C_u is the undrained shear strength of the subgrade. The authors take for N_c, tan β, and m, the values listed in Table 1.

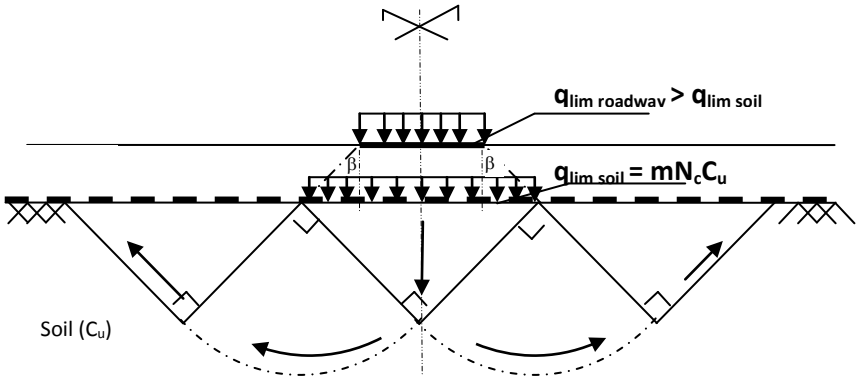

Figure 1: Failure mechanism

Table 1. Values of N_c, tan β and m according to different authors

Authors	Value of N_c			tanβ	m
	Without Reinforcement	With Geotextile	With Geogrid		
Barenberg et al., 1975	3.3	6.00	-	According to Boussinesq	1
Steward et al., 1977	2.8	5.0	-	According to Boussinesq	1
Giroud and Noiray, 1981	3.14	5.14	-	0.6	1
Houlsby and Jewell, 1990	3.07	5.69	-	To choose arbitrarily	1
Giroud and Han, 2004	3.14	5.14	5.71	computable	≤1

Perkins and Ismeik (1997) provide an overview of the majority of experimental studies and numerical analysis, which were conducted on reinforced pavements. Full scale and laboratory scale experimental work carried out until now, show an improvement especially in the rut depth, and substantial gain in the thickness of the pavement. However, these experimental results taken by themselves seem to be insufficient for the development of a recognized process design due to many dependent variables influencing the problem. Moreover, varying degrees of success have been made in the development of finite element models to predict the response of reinforced flexible pavements.

This work deals with numerical simulation using Flac software, to investigate the improvement of the bearing capacity of reinforced unpaved roads over soft clay. The mechanism by which the reinforcement improves the behavior of the roadway under the effect of a static single load is examined. The unpaved road is subject to the

application of a single static load. Although in reality the loading may be over a rather complex area, it was idealized here as a strip loading (plane strain) and the pressure-displacement behavior was determined for small and large strain analysis for unpaved roads with or without reinforcement.

Numerical Simulation with Flac Presentation of the case study

The case study consists to analyze the behavior of a roadway under the effect of a single static load. The roadway, considered here, is an unpaved road that can accept deformations in the form of ruts, which can reach 100 mm, and more. The roadway is considered as a two layer system, consisting of a base layer, made in, selected material, resting on a low bearing capacity soil. The behavior of the roadway, which may be reinforced or not by geogrid, arises, as a plane strain problem of determining the bearing capacity of a shallow strip footing resting on a two-layer soil. Indeed the permanent deformation of the road in the form of a rut justifies the assumption of plane strain.

The problem is formulated, in large strain, to represent the deep ruts that can develop, and are allowable, on unpaved roads. Contacts soil-geogrid and geogrid-base are governed by an interface that has a behavior, elastic perfectly plastic of Mohr-Coulomb. Given the symmetry about the vertical axis, and considering a half-width of foundation, B= ½ a = 0.159 m, the boundary conditions can be presented as shown in Figure 2.

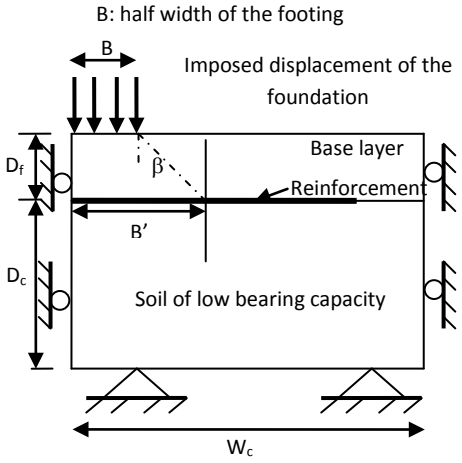

Figure 2: Case Study

Electronic discourse within computer mediated virtual courses supports conversations of practice and learning. The loading of the roadway structure is achieved by imposed displacement of the load until a final displacement, called rut, limited in this work at $\delta = 0.8\ B = 0.8x0.159 = 0.127$ m is reached. It is assumed that beyond this rut depth, the roadway becomes impractical. Therefore the pressure of the foundation necessary to achieve this displacement is considered as the ultimate pressure. The physical and mechanical properties of the materials used are as follows:

Subgrade: E =10 MPa, $\nu = 0.33$, $\rho = 1900$ kg/m3, $C_u = 30$ KPa, Dc = 2.54 m = 16B, W_c =3.18 m = 20B.

Base: E = 50MPa, $\nu = 0.25$, $\rho = 2200$ kg/m3, $\varphi = 40°$, C = 0., $\psi = 20°$, D_f = 0,212m.

Geogrid: E =146 MPa, $\nu = 0.33$.

Interface Soil/geogrid and base/geogrid: kn = ks = $5x10^9$ N/m3, φ=35°, C=0., kn and ks are respectively the normal stiffness and shear stiffness of the interface element.

E, ν, ρ, C_u, φ, ψ, C have the usual meanings, i.e. respectively: elastic modulus, Poisson's ratio, bulk density, undrained shear strength, friction angle, dilation angle and cohesion.

Numerical Analysis with Flac

The plane strain analysis is developed using the software Flac (Fast Lagrangian Analysis of Continua (Flac), 2000). The corresponding mesh is shown in Figure 3. To achieve a final rut (displacement) of $\delta = 0.8B = 0.8x0.159 = 0.127$ m, a downward velocity is imposed to the 4 gridpoints representing the footing. A constant velocity of $-2.5x10^{-6}$ m/step is adopted for the case of a non-reinforced roadway and a velocity of $-1x10^{-6}$ m/step for a reinforced roadway. These velocity values were retained after several preliminary simulations.
The geogrid was modeled as a structural beam, as defined by Flac (2000). The beam adopted has zero inertia, to characterize the membrane effect of the geogrid.

Simulations results and analysis in small and large strains

Load-displacement simulations

The results presented in Figure 4, show the load-displacement simulation of the 4 possible cases, unreinforced road in small strain (BF40C30S), unreinforced in large strain (BF40C30), reinforced in small strain (BF40C30RS) and reinforced in large strain (BF40C30R).

Regarding the improvement in bearing capacity of the structure, provided by the reinforcement, and according to the results obtained with Flac simulations, the improvement is about 29% for small strain analysis (BF40C30S and BF40C30RS simulations). The equivalent analysis in large strain (BF40C30 and BF40C30R simulations) shows an improvement of 46% in bearing capacity. This demonstrates that the reinforcement has a better effect on increasing the bearing capacity of a two-layer system, in large displacement.

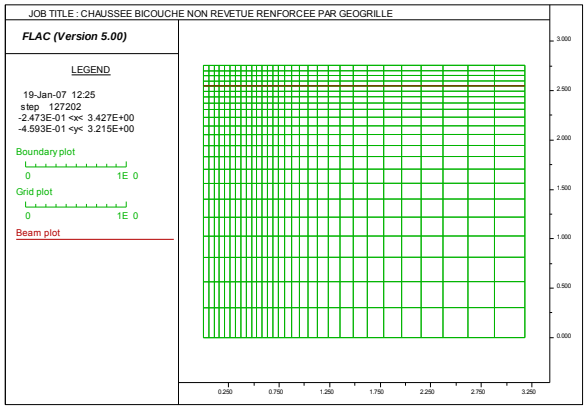

Figure 3: Mesh geometry

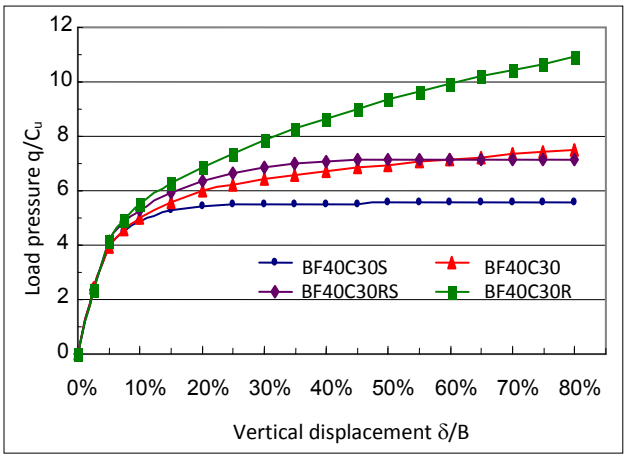

Figure 4: Pressure-Displacement

Tangential stresses acting on the interface soil-base

The analysis of the tangential stresses in figure 5 shows that for an unreinforced roadway the maximum shear stress reached is $\tau = 1.C_u$. on the contrary, for a reinforced roadway, one can note that the geogrid causes the increase of tangential stresses on the upper side of the geogrid, which explains the lateral confinement provided by the geosynthetic, Burd and Brocklehurst (1990). However the stresses are reduced by the reinforcement to a value of $\tau = 0.4\ C_u$ on the subgrade. This shows the effect or the mechanism of reinforcement.

Parametric Study

Effect of the Reinforcement Stiffness on the bearing capacity

Figure 6 shows the variation of the ultimate pressure, with the variation of the geogrid stiffness. We can note the net evolution of the bearing capacity with the increase of the geogrid stiffness. But this improvement, reaches a limit for the stiffnesses exceeding J =1000 KN/m.

Effect of the Stiffness of the Reinforcement on the maximum tension in the geogrid

Figure 7 shows the variation of the maximum tension in the geogrid with the variation of the stiffness of the geogrid. We can note the evolution of the maximum tension with the increase of the stiffness of the geogrid. It can also be noticed that beyond a stiffness of J = 1000 KN/m, the maximum tension in the geogrid continues to increase without any counterparty on the bearing capacity. Therefore, one can conclude that there is an interest to study the ratio stiffness / bearing capacity in order to fix the choice of an optimal geogrid.

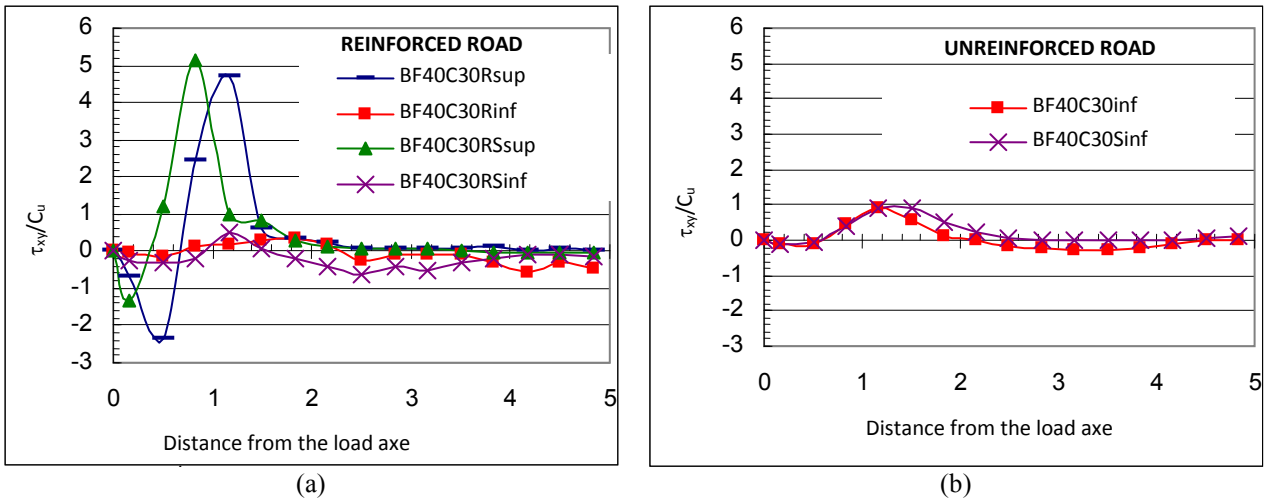

Figure 5: Tangential Stresses acting on the interface soil-base: (a) reinforced road; (b) unreinforced road; sup = upper side of the geogrid; inf = lower side of the geogrid

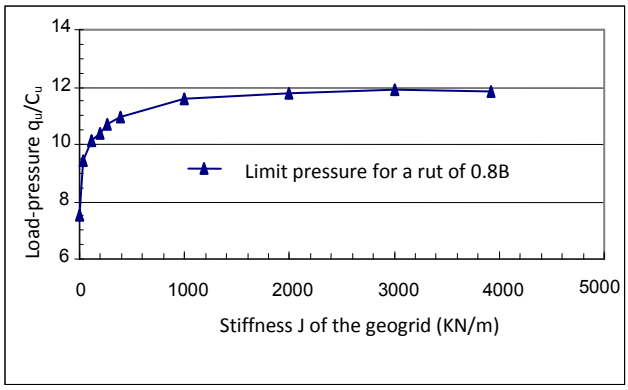

Figure 6: Effect of the stiffness J of the geogrid on the bearing capacity

Effect of the undrained cohesion C_u of the soil supporting on the bearing capacity

Figure 8 shows the expression of the ratio of the ultimate pressure with reinforcement on the same pressure without reinforcement. One notices that the improvement of bearing capacity is higher for soils with low resistance. Indeed the improvement of bearing capacity is 58% for a soil of C_u = 15 KPa, but only 35% for a soil of C_u = 60 KPa.

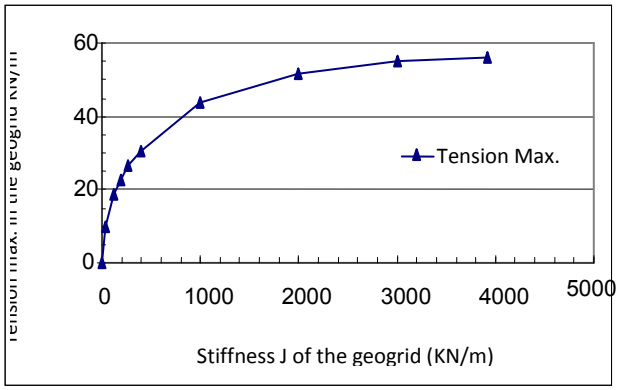

Figure 7: Effect of the stiffness J of the geogrid on the maximal tension on the geogrid

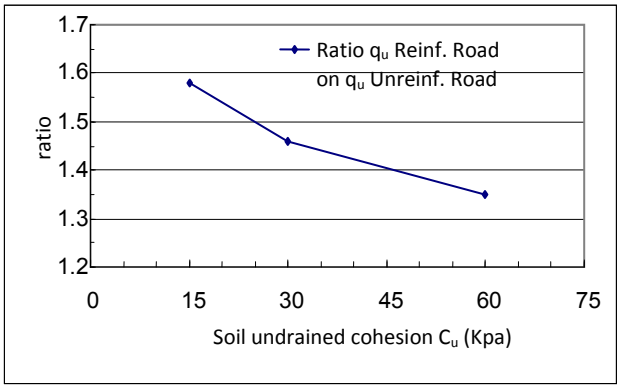

Figure 8: Effect of the soil strength (C_u) on the improvement of the bearing capacity

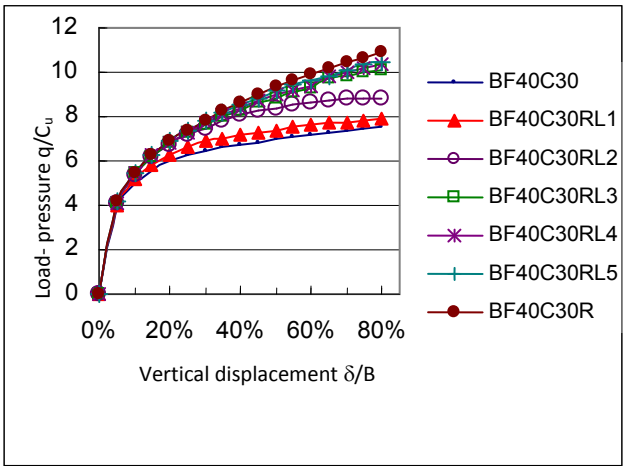

Figure 9: Effect of the anchorage length on the pressure-displacement behavior. Lengths of reinforcement: L1=0.94 B; L2=1.67B; L3=2.17B; L4=2.83B; L5=4B; R=20B

Effect of the anchorage length on the pressure-displacement behavior

Figure 9 shows the pressure-displacement behavior, for seven, different variants, an unreinforced road, a reinforced road, with the anchoring lengths L1 to L5 ranging from 0.94B to 4B and, a basic variant with reinforcement over the entire width of the road. One can notice that an anchoring of L4 = 2.83 B can mobilize a bearing capacity equal to 95% of that mobilized by the same geogrid, anchored on, the entire width of the road.

Conclusions

By analyzing the results of the simulations carried out in this research with the FLAC software, we can conclude the following:

- The large strain simulations show more improvement, in the bearing capacity and, follow better the actual behavior.
- The parametric study on the effect of the stiffness of the reinforcement helps to distinguish two zones: a zone of low stiffness characterized by high sensitivity of the bearing capacity and a zone of high stiffness characterized by an attenuating sensitivity with the increasing of the stiffness. This study explains the conflicting opinions in the literature on this point.
- The maximum tension in the geogrid continues to increase proportionally with the increase of the stiffness without counterparty in the bearing capacity. This raises the interest of the study of the ratio stiffness / bearing capacity for an optimal choice of a geogrid.
- The study shows that the improving of the limit pressure is inversely proportional to the undrained cohesion of the soil.
- The study shows that the length of the reinforcement should be just sufficient enough to mobilize the mechanism of reinforcement.

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Performance of different types of FRP sheets bonded to concrete using flexible adhesive

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Abstract: De-bonding problems stand as a critical barrier against a wide range of usages of FRP composites in structural strengthening and repairing applications. Results of an experimental campaign on FRP-concrete debonding are presented in this study. Specimens with different types of FRP sheets bonded to concrete prism using flexible adhesive were conducted to determine the effective bonding length and ultimate bond capacity of FRP-concrete interface. The experimental results from double lap shear specimens indicated that the flexible adhesive has increased both of the effective bonding length and the ultimate bond capacity of FRP-concrete interface. Increase of fracture energy of FRP-concrete interface has been clearly observed due to flexible adhesive for all different types of FRP sheets. Analytical models available in the literature were adopted to evaluate the bond strength and the effective bond length of the experiment results in this study. Consequently, the existing models need to be modified to consider the type of adhesive layer. A unique feature of the present study is that a simple modification done to the most popular bond strength model, Chen and Teng model (2001), to predict both bond strength and effective bonding length considering the type of adhesive layer. The validation of bond strength model is supported via experiment test results.

Key words: Bond strength model, Flexible adhesive, FRP sheet, Concrete.

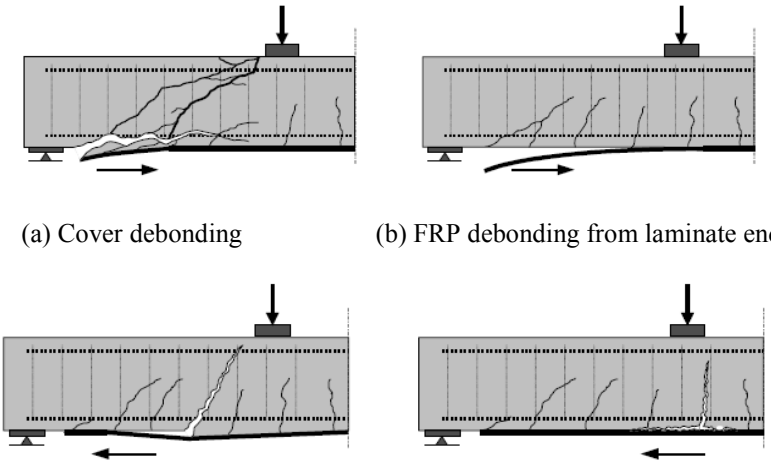
Introduction

External bonding of FRP sheets/plates is an effective and popular method for the rehabilitation of reinforced concrete structures. The mechanical performance, including the strength of the external bonded FRP structural system, is often determined by the bond between FRP composites and concrete. The bond interface, FRP-concrete interface, is usually the weakest link, and debonding at the interface is usually the critical failure mode. Debonding initiation in beams strengthened with FRP composites generally take place in regions of high stress concentration at the concrete-FRP interface. These regions include the ends of the FRP reinforcement, and those around the shear and flexural cracks (Buyukozturk et. al. 2002). Figure 1 shows the fundamental debonding mechanisms that may result in premature failure of FRP strengthened beams. Thus, determination the bond capacity of the FRP-concrete interface is an important subject, and has attracted extensive research till now (Caggiano at. al. 2012, Wu at. al. 2012, Wu at. al. 2012, Tuakta and Büyüköztürk 2012).

Based on the extensive tests, researchers concluded that bond capacity is affected mainly by mechanical and physical properties of concrete, thickness and stiffness of the FRP, thickness of the adhesive, and the bonded length (Chen & Teng 2001, Neubauer & Rostasy 1997, Wu at. al. 2009). However, some researchers concluded that thickness of the adhesive has negligible effect on mean and peak shear stresses (Hamoush and Ahmed 1990, Nakaba at. al. 2001). Analytical models have been proposed in order to predict the behaviour and the ultimate bond strength of the FRP-strengthened system. It is interesting to note that most of the existing models, which are in reasonable agreement to experimental results(Chen & Teng 2001, Neubauer & Rostasy 1997, Wu at. al. 2009), neglect the adhesive layer properties.

Indeed, a number of researchers investigated the effect of flexible adhesive on the bonding of FRP sheets (Xia & Teng 2005, Dai at. al. 2005). Dai et. al.(2005) provided a summary report on the flexible bonding system. The contents included the bond characteristics of FRP/concrete joints, strength and ductility of FRP strengthened

RC beams. It is concluded that the flexible bonding system with a sufficient long anchorage can achieve higher bond capacity and a ductile failure. Moreover, Dai and Ueda (2003) considered the effect of adhesive layer stiffness by considering different thicknesses of the adhesive layer and they concluded that the use of adhesive with lower stiffness may lead to higher bond capacity. On the other hand, Xia and Teng (2005) studied the interfacial behaviour of FRP plates bonded to steel member using different adhesive types. It was concluded that properties of adhesive have a significant effect on the bond capacity of FRP-steel joints.



(a) Cover debonding (b) FRP debonding from laminate end

(c) FRP debonding from flexure-shear cracks (d) FRP debonding from flexural cracks

Figure 1: Debonding failure mechanism of FRP strengthened beams

So far, none of the existing proposed models have gained general acceptance by the research community due to their limited success and applicability. Continued research is needed in this area to understand and model debonding failures in FRP strengthened concrete structures. On the other hand, most existing models were developed from results of single or double test methods of FRP-bonded concrete blocks using ordinary adhesive (one kind of epoxy). In turn, most of these bond strength models neglect the effect of adhesive properties and therefore the corresponding applicability to the structural system remains challenged. A reliable and efficient model should be established through a comprehensive understanding of adhesive layer type role on FRP-concrete strengthening systems.

Experimental program

A series of double-lap shear specimens with adhesively bonded FRP sheets were conducted to investigate the bond capacity, effective bond and fracture energy of flexible adhesive FRP-concrete interface.

Material and specimens details

Double-lap shear specimens with concrete dimensions 100x100x450 mm^3 have been used in this study. Details of the test specimens are shown in **Photo 1**. The compressive strength of concrete after 28 days was 40.0 MPa.

FRP sheets:-

FRP sheet layers were bonded to both sides of the concrete blocks along the axial direction and the bonded length was kept fixed at 250 mm, for all specimens. Two different types of FRP sheets were adopted in this study.

The mechanical properties of the FRP composites and their nominal thickness of FRP fibers are shown in Table 1. Properties of Fibers are provided by manufacturers.

Table 1: Summary of mechanical properties of different fiber sheets

Types of Fibers	Fiber Aerial Weight (g/m2)	Thickness (mm)	Modulus of Elasticity (MPa)	Tensile Strength (MPa)	Rupture Strain (%)
Carbon fiber	300	0.167	230 x103	3400	1.48
Basalt (BUF7-300)	300	0.17	91.0 x103	2100	2.6

Adhesive

FRP sheets were bonded to the concrete prisms with a flexible type of Epoxy resin. The brand of adhesive used in this study is CN-100 for flexible adhesive layer. The CN-100 epoxy has a modulus of 0.39 GPa, a tensile strength of 11.8 MPa and an elongation of 50%.

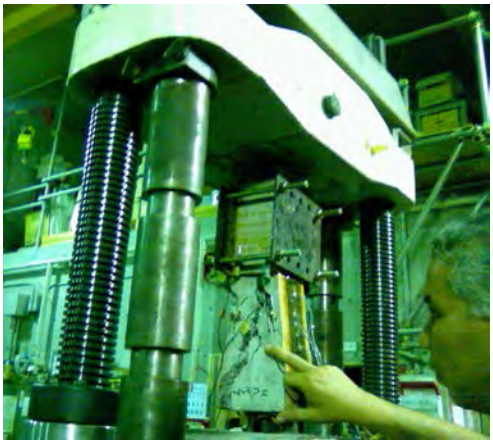


Photo 1: Experimental Set-Up

Instrumentation and Testing Procedure

Seven strain gauges with 6 mm length were mounted on FRP sheets to monitor debonding deterioration along FRP-concrete interface. During each test, the global slip, which is defined as the relative displacement between the two concrete blocks, was measured using four clip strain gauges that were attached on free sides of concrete prism. Two clip strain gauges attached near each FRP sheet as shown in **Photo 1**. Tensile load is applied by pulling both ends of steel bars embedded in the concrete prism, with rate 2 kN per minute until failure.

The specimens were labeled within alphanumeric designation (Table 2) depending upon the type of the FRP sheets, adhesive layer and number of FRP sheet layers. The number following the hyphen represents the number of specimen. Two types of FRP composites were considered in this study; carbon fiber reinforced polymer, CFRP, and basalt fiber reinforced polymer, BFRP. The test temperature was about 22-24 ^{o}C. Table 2 summarizes the number of specimens, their parameters and their results.

Experimental Results and Discussions

The complete experimental results for all specimens are listed in Table 2. The ultimate displacement is defined as the value of relative displacement between the two concrete blocks at the maximum load. The effective bonding length (Le) is defined as the distance from the pre-crack of prism specimen to the position where 97% strain of the value at the pre-crack occurs (Yoshizawa et. al. 2000) The interfacial fracture energy, Model II, Gf, represents the total external energy supply, per unit of area, required to create, propagate and fully break a crack along the FRP-concrete interface. The FRP-concrete interface is determined from the following equation:-

$$G_f = \frac{P^2}{2b_f^2 E_f t_f} \quad (1)$$

Where P is the tensile force of one lap FRP laminate, b_f , E_f and t_f are width, modulus of elasticity, and thickness of the FRP sheets, respectively.

Table 2: Specimens' data and key results from bond tests

Specimen	Type of FRP Sheets	No. of FRP Sheets	Ultimate Load (kN)	Max. Displ. (mm)	Fracture Energy (N/mm)	Effective Bonding Length	Failure Mode
BFRPL1-1	Low adhesive (CN-100)	1	24.23	1.74	1.94	110	(B)
BFRPL1-2		1	21.90	2.6	1.58		(C)
BFRPL1-3		1	17.40	1.99	1.00		(B)
BFRPL2-1		2	19.89	1.51	0.65	210	(B)
BFRPL2-2		2	22.25	1.41	0.82		(B)
BFRPL2-3		2	23.60	1.48	0.91		(B)
BFRPL3-1		3	32.45	1.39	1.16	>250	(B)
BFRPL3-2		3	44.19	1.75	2.15		(B)
BFRPL3-3		3	36.80	1.63	1.49		(B)
CFRPL1-1		1	43.8	1.57	2.50	200	(A)
CFRPL1-2		1	41.6	1.24	2.25		(C)
CFRPL1-3		1	37.65	1.35	1.85		(C)
CFRPL2-1		2	48.4	0.91	1.52	250	(D)
CFRPL2-2		2	44.62	1.10	1.30		(D)

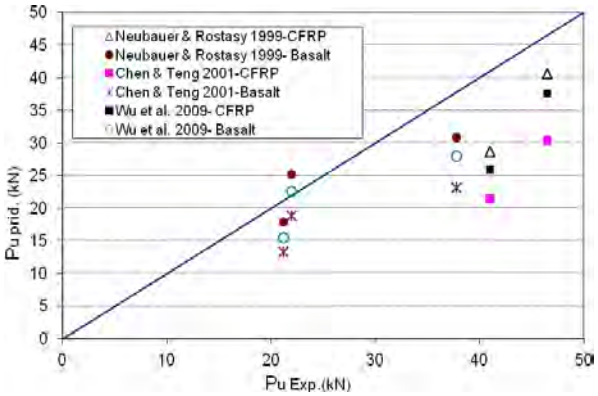


Figure 2: P_u predicted versus P_u experiment for different types of FRP composites using Flexible adhesive layer

Bond Strength of the FRP-Concrete Interface

Load carrying capacity is an important reference for selecting the optimum bonding adhesive. There was a clear reinforcement action which was achieved by application of low adhesive with different types of FRP sheets. Figure 2 shows experimental ultimate bond strength versus predicted ultimate bond strength. The bond strengths were calculated using the most accurate and appropriate bond strength models which were proposed by Wu et al. (2009), Chen and Teng (2001), and Neubauer and Rostasy (1997). Details of these models can be found in their references.

It is clear that these models underestimate the bond strength of all specimens except one specimen which has low FRP stiffness, i.e. BFRPL2 and BFRPL1. It seems that the accuracy of the bond strength model depended on the type of adhesive layer as shown in Figure 2. These results emphasized that low adhesive layer can be successfully used to increase the bond capacity of the FRP-concrete interface. The improvement in ultimate strength for specimens using flexible adhesive layer was likely attributable to the larger ductility of the adhesive.

CFRPL1-1 (A) BFRPL1-3 (B) CFRPL1-2 (C) CFRPL2-2 (D)

Figure 3: Typical failure mode of FRP specimens

Failure Modes

In the previous study, debonding along FRP-concrete interface has been observed to be the failure mode for most of specimens which were bonded with ordinary epoxy (EF-E3P) as an adhesive layer. This type of debonding initiated by shear failure in the concrete near the loaded end and followed by the debonding along the weakest component of the bond joint (failure mode A).

In the present study, in addition to failure mode A, three other different failure modes are indentified from the experimental investigation of the specimens used flexible epoxy, CN-100, as an adhesive layer as shown in Figure 3. The failure mode "B" has a debonding at interface between epoxy and epoxy resin and failure mode "C" is also observed due to the rupture of the FRP composites while failure mode "D" results due to crushing of the concrete block along the steel bar of specimens. Failure mode "D" has the maximum load carrying capacity. Therefore this capacity is depended on the strength of concrete and shape of specimens as the failure is in concrete rather FRP-concrete interface. Consequently, the number of CFRP sheets was not increased than two layers.

For BFRP specimens with low adhesive layer; although higher load capacity is observed, but the failure mode B occurs instead of failure of mode A as observed in BFRP specimens with ordinary adhesive (Diab and Wu 2009). On the other hand, specimens with the higher Young's modulus of the FRP sheet (CFRP) and the lower adhesive stiffness will result in the maximum bond capacity of the FRP-concrete interface. It can be concluded that the load

carrying capacity and the failure mode of the FRP-concrete interface not only depends on the FRP sheet stiffness, bond length, surface treatment and concrete strength as mentioned in previous studies (Mazzotti at. al. 2008), but also depends on the type of adhesive layer stiffness which is the important factor and should be taken into consideration.

Interfacial Fracture Energy

Equation 1 can be used to predict the interfacial fracture energy G_f (model II). The values of interfacial fracture energy for each specimen are shown in Table 1. It is observed that the interfacial fracture energy of specimens of flexible adhesive layer fall within the range between 0.82 and 2.25 N/mm. On the other hand, previous studies concluded that the interfacial fracture energy of FRP-concrete interface using ordinary adhesive falls within the range between 0.68 and 1.09 N/mm (Mazzotti at. al. 2008, Teng at. al. 2005). Consequently the fracture energy also depends on the properties of adhesive layer.

Effective Bond Length

Figure 4 shows a comparison between predicted effective bonding length ($Le_{Prid.}$) and experimental effective bonding length which was determined from experiment results ($Le_{Exp.}$) as mentioned previously. Such figure shows that the effective bonding lengths of specimens with flexible adhesive layer are higher than those obtained using the previous mentioned models. The effective bonding length of specimens using flexible adhesive is nearly equal or greater than bond length as shown in Table 1, except specimens BFRPL1-1,2,3. Therefore the bond capacity of these experimental specimens may be less than the actual bond strength if the bond length is greater than the effective bond length. Nevertheless, clear increases in bond capacities were observed for CFRP specimens which are of bond lengths less than the effective bond lengths.

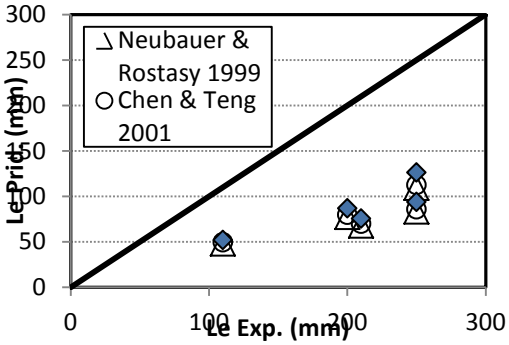


Figure 4: Le predicted versus Le experiment for different types of FRP composites using Flexible adhesive layer

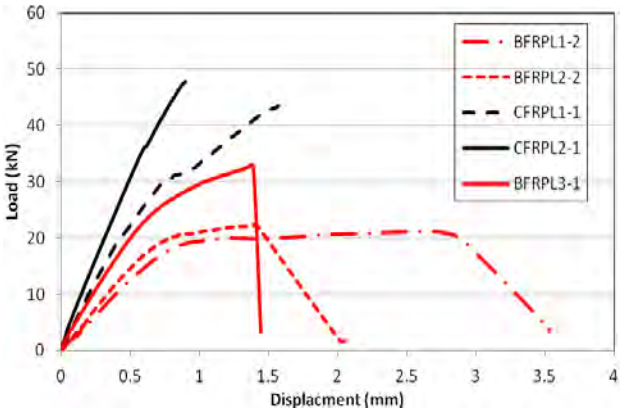


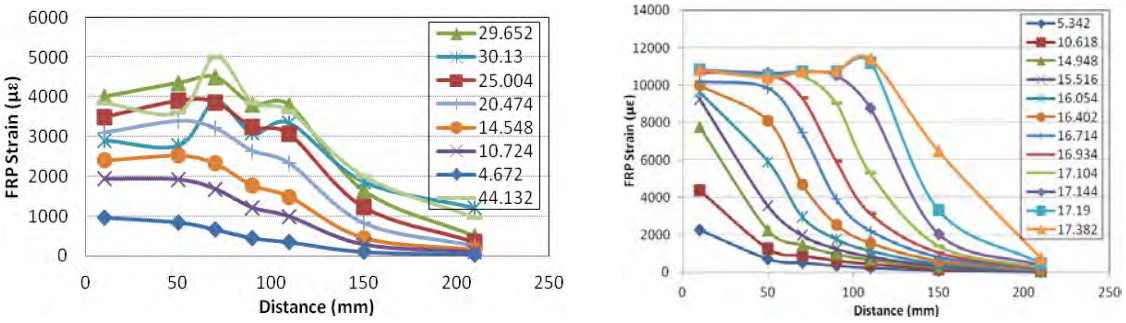
Figure 5: Load-Slip Relationship of Specimens

Load-Displacement Behavior

Figure 5 shows the typical load-displacement relationships of flexible adhesive layer's specimens of different types of FRP sheets (Carbon and Basalt). The slips (or relative displacement between two concrete prisms) of the FRP sheets represent the average values of the four clip gauges attached to each specimen. Such figure shows that the bond capacity of BFRPL1-2 and BFRPL2-2 specimens had reached its maximum carrying capacity as the Load-displacement curve moved horizontally after debonding. However, in the case of other specimens, the bond Force still showed increasing tendency after debonding initiation. This behaviour confirms that the effective bonding length of these specimens is greater than the bond length as mentioned previously. Therefore, it is possible for these specimens to achieve higher bond capacity if the bond length is increased. Specimens with flexible adhesive layer improved ductility of the FRP-concrete interface when the bond length is longer than the effective bonding length.

FRP sheet strain distribution

Figure 6(a and b) shows typical FRP sheet strain distribution along the bonded length at different load levels for CFRPL2-2 and BFRPL1-3 specimens, respectively. Profile of FRP strains is almost linear and the strains decrease smoothly along the bonded length within a distance range from 100 to more than 200 mm based on the FRP sheet stiffness. These results are dissimilar to those already reported in other papers (Mazzotti at. al. 2008) for ordinary adhesive layer. By comparing between the two FRP strain profiles, it is noticed that the effective bonding length of BFRPL1-3 is less than the bond length while the effective bonding length of CFRPL2-2 is longer than the bond length. According to these results, the adhesive layer with low stiffness increases the effective bonded length which results in the redistribution of bond stresses along the bonded length and in turn increases the bond capacity. This result is similar to that reported in previous study by the author (Wu and Diab 2007) which concluded that the increase of effective bonding length due to creep of adhesive layer result in the redistribution of bond stresses along the bonded length which prevents debonding propagations along FRP-concrete interface.



(a) Specimen CFRPL2-2 (b) Specimen BFRPL1-3

Figure 6: FRP-Sheet strain distribution along the bonded length of specimens

Prediction of Bond Strength using a Proposed Bond Strength Model

Analytical models for estimation of bond strength, available in the literature, are evaluated on the basis of 351 bond tests performed in the past by Toutanji et al. (2008). It is found that the formula proposed by Chen and Teng (2001) better predicts the experimental measurements for all types of composite materials. Even though, this model fails to correctly predict bond strength of specimens in this study as the FRP sheets bonded to concrete using flexible adhesive. This model and the others give underestimating values as mentioned previously. This study confirms that the adhesive layer is able to increase the bond capacity of FRP-concrete interface. Therefore, the type of adhesive layer should be considered through all exciting models. In this study the most accurate bond strength model introduced by Chen and Teng (2001) will be modified to consider the type of adhesive layer based on the limited number of experiments available in this study. The bond strength of an FRP-concrete interface of simple shear joint based on the Chen and Teng (2001) model is represented by;

$$P_u = 0.427\beta_p\beta_L b_f L_e\sqrt{f_c'} \tag{2}$$

$$L_e = \sqrt{\frac{E_f t_f}{\sqrt{f_c'}}},\quad \beta_p = \sqrt{\frac{2-b_f/b_c}{1+b_f/b_c}},\quad \beta_L = 1 \text{ if } L \geq L_e;\ \beta_L = \sin\frac{\pi L}{2L_e} \text{ if } L \leq L_e \tag{3}$$

where E_f, t_f, b_f are modulus of elasticity, thickness and width of FRP sheets, respectively; f_c', b_c are the concrete compressive strength and width of concrete block, respectively; L_e, L are the effective bonding length and bond length, respectively.

Experimental results showed that the flexible adhesive layer increases the effective bond length which results in the redistribution of shear stresses along the bonded length and in turn increases the bond capacity of FRP-concrete interface. Therefore; a coefficient β_a is proposed to the effective bonding length and to the bond strength equations of Chen and Teng model (2001). From the regression of the limited test data available in the present study,

the factor β_a is represented as

$$\beta_a = \sqrt{\frac{E_a}{2.45}} \quad (4)$$

Where E_a is the modulus of elasticity of adhesive layer in GPa.

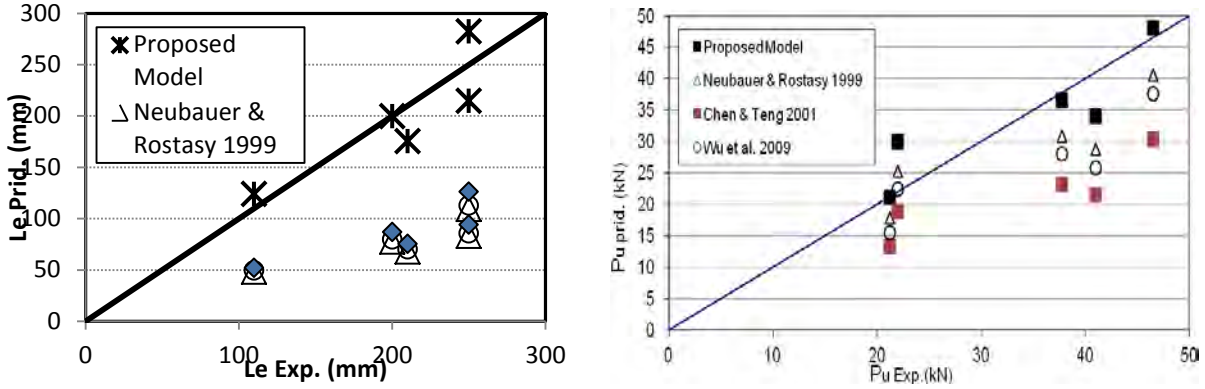
Equations (2, 3) for effective bonding length and bond strength of FRP bonded joint can be modified to include the adhesive factor, β_a, as

$$L_e = \sqrt{\frac{E_f t_f}{\beta_a^2 \sqrt{f_c'}}} \quad (5)$$

$$P_u = 0.427 \beta_p \beta_L b_f L_e \sqrt{\beta_a f_c'} \quad (6)$$

Comparing the Proposed Bond Strength Model to other Existing Models

The results of the proposed model and those which were obtained from the three selected models for the specimens in the present paper are presented in Figure 7. It is clear that the proposed model predicts satisfactory the effective bonding length and the bond strength that were measured experimentally. It can be seen that the other models underestimate the bond strength and the effective bonding length. The main cause for the poor performance of these models is due to neglecting the type of adhesive.



(a) Effective Bonding Length (b) Bond Strength

Figure 7: Test versus Predicted Results

Conclusion

This study has presented an experimental program on the bond performance of FRP sheets bonded to concrete with flexible adhesive. The type of adhesive has an effect on both the effective bond length and the bond strength of FRP-concrete strengthening system. From the experiment results and the comparative studies of some analytical models for bond strength, it is noticed that the flexible adhesive layer increases both of the effective

bonding length and the ultimate bond strength. Flexible adhesive layer has improved ductility of FRP-concrete interface which is crucial to improve ductility of FRP strengthened beams. Finally, the evaluation of bond strengths of the experiment results using various existing models showed that these models need to be modified to consider the type of adhesive layer. Based on the statistical analysis of a limited number of shear test results, which were devoted in this study to investigate the effect of adhesive layer on FRP-concrete interface, the Chen and Teng bond strength model(2001) has been modified taking into its consideration the type of adhesive layer.

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Pre-service teachers' perceptions about their own learning styles

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Abstract: The purpose of the study was to investigate pre-service teachers' perceptions of their own learning styles. The study was carried out with 144 pre-service teachers. Participants of the study were instructed about learning styles and also the features of the visual, auditory and kinesthetic learning styles were explained in depth. Pre-service teachers were asked open-ended questions regarding what might be the most appropriate learning style to them. The data were coded and grouped under relevant categories. The findings indicated that most of the pre-service teachers believe that they have visual (49.8%) learning style. 28.9 percent of the pre-service teachers perceive themselves as kinesthetic and 23.3 percent of them are of the opinion that they are auditory. Besides, some of the pre-service teachers have also expressed that they have more than one learning style.

Key words: Learning styles, pre-service teachers, learning.

Introduction

With increasing importance attached to cognitive conception of learning arguing that learning is an active intellectual process and constructivist approach assuming that learning is a personal endeavor, greater emphasis has been put on individual differences in the field of education. Cognitive and constructivist learning approaches have drawn the attention to the reception of information by the learner, processing of it and constructing of it. These processes occur in different ways for different individuals; hence, individual differences should be taken into consideration in learning. One of the individual characteristics of the learner regarded to be important in learning process is learning styles.

Learning styles can be described as approaches specific to an individual learner used during the processes of reception and processing of information. When the models explaining learning styles having cognitive, affective and physiologic dimensions are examined, it can be concluded that learning styles are specific to individuals. The models emphasizing the cognitive dimensions of learning styles are concerned with the reception of information, processing, storing, encoding and decoding of it. The models emphasizing the affective dimension are concerned with the personality characteristics such as motivation, attention, locus of control, interests, willingness to take risks, perseverance, taking responsibility and liking social life. The learning styles models emphasizing physiological dimension are concerned with the perception through senses (visual, auditory, kinesthetic, and tactile), properties of the setting (level of noise, heat, light and organization of the room), sustenance (need for food and drink) and biorhythms (in which part of the day, they feel the best to learn) (Başıbüyük, 2004; Dağhan & Akkoyunlu, 2011). These models dealing with the different dimensions of learning styles explain learning styles through different classifications.

According to Given (1996) learning style models tend to fall into one or more of the following five categories: a) personality and emotional models, b) psychological, cognitive and information processing models, c) social models, d) physical models, and e) environmental and instructional models. Kolb (1984) constructed a bidimensional model resulting in four basic types or styles: diverger, assimilator, conveger, and accommodator. The vertical axis in Kolb's model represents a continuum of preferences for how information is grasped or perceived which ranges from apprehending concrete experiences to comprehending abstract concepts. The horizontal axis represents how information once perceived is transformed into meaning. At one end is active experimentation with

reflective observation at the other end. It is the crossing of these two continua that creates Kolb's four major learning styles. Anthony Gregorc (1982) also created a bidimensional model and he called his four "mind channels" concrete sequential, abstract sequential, abstract random, and concrete random learning styles. Gregorc believes that individuals can adjust to varying circumstances through their non-dominant channels so long as the dominant style is permitted opportunity to develop. Dunn and Dunn (1992; 1993) investigated emotional factors of style including how students are motivated to learn, how persistent they are when pursuing a task, and the level of responsibility assumed for completing the task. Grasha (1972) developed learning style scales which included aspects of personality to social preferences: independent, dependent, collaborative, competitive, participant, and avoidant learning patterns. Brandt (1983) identified three dysfunctional styles that may appear functional. They were the acquiescent, self-important, and deprived styles. McCarthy (1987) developed the 4MAT System based on brain hemisphericity. The result was a quadrilateral curriculum design with each quadrant divided into left brain/right brain characteristics. McCarthy advocates designing lessons according to the eight step sequence that includes: a) creating an experience-right mode, b) reflecting, analyzing experience-left mode, c) integrating reflective analysis into concepts—right mode, d) developing concepts, skills-left mode, e) practicing defined "givens"-left mode, f) practicing and adding something of oneself-right mode, g) analyzing application for relevance, usefulness-left mode, and h) doing it and applying to new, more complex experience-right mode (Given, 1996).

Sensory modalities (visual, auditory and kinesthetic) are other primary ways researchers categorize learning style. A modality approach has high face validity because of its practical clarity. Because individuals often display insights into the way they best learn (Given, 1996). For example, visual learners are natural at reading, spelling, proofreading, remembering faces of people (but forgets names), remembering details and colors and creating mental (visual) images. Visual learners solve problems by reading information, listing problems, by preparing graphic organizers to organize thoughts and by using flow charts. Also they learn best by taking notes, making lists, by reading information, by learning from books, videotapes, filmstrips, printouts and by seeing a demonstration. Besides, visual learners read for pleasure/relaxation. They can spend long periods of time studying and require quiet during study. They read rapidly and learn to spell words in configurations rather than phonetically. The difficulties in schools of visual learners can be listed as need to take action before seeing what needs to be done; working in an environment with noise or movement; tuning out sounds; listening to lectures without visual picture or illustrations; dealing with unappealing physical appearance of teacher; working in classrooms with no decorations or drab colors; working under fluorescent lights - makes is hard to concentrate for visual learners. On the other hand for auditory learners, speaking extemporaneously, noticing sounds in environment, remembering names of people (forget faces), and working with words and languages are natural. Auditory learners solve problems by talking about options, by asking others what they would do in a situation, by verbalizing the goal until it sounds right and by auditory repetition. They learn best by talking aloud, by listening to a lecture, by discussing in small or large groups and by hearing music without words as a background in the learning environment. Auditory learners read dialogues and play and sub vocalizes internally or externally for comprehension. They stop while reading to talk to self or others about what is read and they are good at phonetically sounding out new words. The difficulties that auditory learners can be encounter in schools are: reading quickly while they read more slowly than visual learner; reading silently for prolonged periods of times; reading directions while they often unaware of illustrations; taking timed tests that must be read and written; living with enforced silence (can't wait to talk); and seeing significant details. Some other learners, who are natural at sports, dance, adventure, competition, challenge, running, jumping, leaping, rolling and at action using large motor muscles classified as kinesthetic learners. These learners solve problems by taking action, then planning based on results and by attacking problems physically. They seek solutions that involve great physical activity and prefer to solve problems individually or in small groups. Kinesthetic learners learn best by doing, hands-on approach -- manipulation, simulations, live events. They need to be physical involvement in learning. Field trips to gain knowledge and small group discussions are the ways that they learn best. A kinesthetic learner reads primarily for meaning and function, rather than enjoyment. He/she reads action-oriented books/plays and studies for short periods interspersed with moving around. They usually lay on floor or bed to study. The difficulties that the kinesthetic learners can be encounter in school are: sitting still; listening to lectures of more than four minutes; spelling; recalling what was seen or heard (remember everything that was done); expressing emotions without physical movement. (http://www.westga.edu/~jdbutler/ClassNotes/learnstyles.html)

Researches reveal that when students are taught through their preferred learning style they demonstrate: a) statistically significant improvement in their attitudes toward instruction, b) increased tolerance for cognitive diversity, c) statistically significant increased academic achievement, d) better discipline/behavior, and e) greater

self-discipline for homework completion (Given, 1996).

If a student knows his/her learning style and utilizes it during learning process, he/she can learn more easily and faster and be more probably successful at the end of the learning process (Biggs, 2001; cited in Dağhan & Akkoyunlu, 2011). In addition, what is important for students' achievement is not only knowing which style is their preferred one but also knowing whether they are aware of the characteristics of their dominant style or not (Dağhan & Akkoyunlu, 2011). Aşkar and Akkoyunlu (1993) state that one's knowing which learning style is the best for himself/herself may help him/her to enhance his/her learning potential. Besides Babadoğan (2003) report that when the students with poor academic achievement make use of their dominant learning styles, they can significantly improve their learning performance. When learning styles are systematically taught to students, in a short time, improvement is seen in the amount of information learned and retention of it (Given, 1996).

Students' having quality information about their learning styles thought to contribute to their cognitive and affective qualifications throughout supporting their learning. Being informed about one's own learning style is important because, this leads to their effective arrangement of their learning processes and improvement of their academic achievement and self-confidence. For pre-service teachers to be effective in their professional teaching career, they need to be made aware of their learning styles, which contribute to their achievement and their self-confidence during their learning processes. In light of these facts, the present study aims to investigate the pre-service teachers' perceptions of their own learning styles. Pre-service teachers' being informed about learning styles may help them to take their own students' learning styles into consideration while designing their lessons, so that they will be able to design lessons matching the learning styles of their students in the future.

Method

The present study investigating the pre-service teachers' perceptions of their own learning styles employs qualitative research methods. Totally 144 pre-service teachers from the departments of English Language Teaching, Mathematics Teaching, Science Teaching and Social Studies Teaching participated in the present study. The pre-service teachers were informed about learning styles and detailed explanations were given about the characteristics of visual, auditory and kinesthetic learning styles and some examples were presented. Şimşek (2002) stated that a student tend to use one of these learning modalities. Open-ended questions were asked to the participants to determine which learning style they think is most suitable for themselves. The data obtained were coded and collected under the related categories. The results that found by calculating the frequencies and percentages were arranged and then interpreted. Furthermore relevant quotations from pre-service teachers' responses were presented.

Results

The findings of the study were obtained by reducing the statements in the responses given to the open-ended questions. 49.8% of the students participating in the present study think that they have visual learning style. In Table 1, the frequencies and percentages calculated for the statements of the students thinking that they have visual learning style are presented.

Table 1: Frequencies and percentages of the students' statements, who think that they have visual learning style.

Statements	**f**	**%**
I take detailed notes.	27	22.0
I am successful in interpreting and learning visual items.	21	17.1
I best learn and understand by seeing/reading	13	10.6
I make observations.	3	2.4
It is important for me to watch my teacher.	10	8.1
I do not forget what I have seen.	20	16.3
I cannot understand the things I haven't read.	3	2.4
I can visualize the things I have read/learned.	20	16.3
I get distracted unless I make eye contact.	1	0.8
I can learn better by writing.	2	1.6
While studying, I make use of drawings and colors.	3	2.4

As can be seen in Table 1, the pre-service teachers thinking that they have visual learning style state that they can learn better by seeing, understand visual things better, like taking notes and they work by drawing. Theses pre-service teachers also stated that they visualize what they have learned and read and they do not forget what they have seen; hence, their dominant learning style is visual. Some of the quotations from the statements expressed by the pre-service teachers thinking they have the visual learning style are as follows:

"I solve the problems by visualizing where or on which page their answers are."

"I take detailed notes and I only understand the notes I have myself taken."

"The things which I have only listened quickly fade away from my mind; I remember the notes taken in great detail."

"While listening to the lesson, I closely watch my teacher's behaviors. I feel as if I could not understand if I do not see my teacher."

"I do not forget easily what I have seen."

"While listening to the teacher, I do not focus on what he/she says rather the visual presentations prepared by him/her."

"In order to retain information, I must read it myself, I cannot understand the subject when others explain it to me."

"When I go to a destination I do not know, I do not get the directions from others, I myself look at the map and visualize it."

The percentage of the pre-service teachers thinking that they have auditory learning style was found to be 21.3. Percentages and frequencies calculated for the statements of the pre-service teachers thinking that they have auditory learning style are presented in Table 2.

Table 2: Frequencies and percentages of the students' statements, who think that they have auditory learning style.

Statements	f	%
I can listen to for a long time, I like listening.	3	6.5
I am highly interested in tone of voice and stresses.	7	15.2
I learn better when I study by telling	2	4.3
I am sensitive to sounds.	4	8.7
I learn/understand better by listening.	15	32.6
I do not forget what I have heard.	3	6.5
I revise the subjects by talking/reading/discussing/interpreting loudly.	10	21.7
I record and listen to my own voice while studying.	1	2.2
I repeat orally not to forget.	1	2.2

As can be seen in Table 2, the pre-service teachers thinking that their dominant learning style is auditory stated that they generally prefer to study by reading loudly, they are interested in the tone of voice and stresses and they best learn by listening. Moreover, these pre-service teachers stated that they like listening and speaking for a long time, they do not forget what they have heard; hence, their learning style is auditory. Some quotations from the responses of pre-service teachers thinking that their dominant style is auditory are given below:

"When I listen to the topics from others, I understand better and they become more permanent."

"When I read novels loudly, I understand more easily."

"When there is no silence in the setting, I cannot concentrate."

"I revise for my exams by telling myself or listening from others, I clearly remember the tone of voice and stresses of the narrator."

"While studying, I study loudly; even while I am solving problems I explain them loudly to myself."

"I repeat the information which I mustn't forget loudly to myself ."

"While studying, it is more effective to study by hearing my own voice."

"Rather than reading what has been written on the board by the teacher, I prefer to listen to him/her explaining the topic."

The percentage of the pre-service teachers thinking that they have kinesthetic learning style is 28.9. The percentages and frequencies calculated for the statements of the pre-service teachers thinking that they have kinesthetic learning style are presented in Table 3.

Table 3: Frequencies and percentages of the students' statements, who think that they have kinesthetic learning style

Statements	f	%
I do not like staying motionless/passive for a long time.	16	25.4
While studying, I like touching my fingers/pens/hair etc.	8	12.7
I learn better by doing.	10	15.9
I am good at designing projects/plans/drafts.	8	12.7
Using materials facilitates my learning.	2	3.2
I can understand better when I touch/feel.	7	11.1
I do not forget what I have done and others' movements	5	7.9
I talk by using my hands/body/gestures and mimics.	7	11.1

As can be seen in Table 3, the pre-service teachers thinking that they have kinesthetic learning style stated that in general they learn better by doing, they get bored with staying motionless for a long time, they like doing projects and they use their body while solving problems, thinking or speaking. Moreover, these pre-service teachers stated that use of materials facilitates their learning and they can only understand by touching the material; hence, their dominant learning style is kinesthetic. Some of the statements of the pre-service teachers thinking that they have kinesthetic learning style are presented below:

"I cannot listen to the lesson for a long time without moving. While studying, I need to walk around with the book in my hands; otherwise, I cannot learn fast enough."

"I cannot sit and listen for a long time. I learn something by myself touching."

"I usually feel bored while writing; I can commit many punctuation mistakes while writing."

"I cannot add numbers fast, I need to count with my fingers first."

"While telling something to someone I always move. While imagining, I like animate with my hands."

"When I read a recipe of a cake or someone tells it to me, I do not understand it, I need to watch it being cooked or do it myself."

"Even if I see someone solving a problem, I cannot understand it well without doing myself."

"My friends always tell me 'why you are touching the things you see'."

Some of the pre-service teachers participating in the present study stated that they have more than one style. Some quotations of these pre-service teachers' statements are given below:

"If one tells the topic to me and uses some kind of visualization while explaining, my learning becomes more effective."

"I understand the lesson by listening but visual materials strengthen my understanding; that is, I need both to hear and see to learn."

"Figures, pictures and maps draw my attention and with these materials I learn better. I do not only watch but also want to touch and describe the materials."

The findings of the present study show that the dominant style preferred by nearly half of the pre-service teachers (49.8%) to learn matches with visual learning style. This is followed by the pre-service teachers thinking that they have kinesthetic learning style (28.9%). The least preferred style by the pre-service teachers is auditory among the learning styles (21.3%).

Conclusions and Discussion

The effects of learning styles on learning and their contribution to the organization of the learning environment have been reported in related researches (Felder, 1993; Given, 1996; Babadoğan, 2000; Collison, 2000; Hein & Budny, 2000). Unlike the studies carried out to determine the learners' learning styles, the present study looks at the learners' perception of their own learning styles. When pre-service teachers are aware of their own

learning styles, even if they encounter different teaching settings, they can effectively organize their own learning processes. Therefore, the present study aims to investigate which learning style the pre-service teachers think they posses rather than determine their learning styles.

In light of the findings of the present study, it can be argued that the most common style adopted as primary style by the pre-service teachers is visual learning style and this is followed by kinesthetic and auditory learning styles, respectively. The pre-service teachers thinking that they have visual style stated that they learn better by seeing and reading, they understand visual elements better, they like taking notes and they study by drawing figures and shapes. As they visualize what they have learned and read in their minds and as they do not forget what they have seen, they think that their dominant style is visual. Some of the pre-service teachers stated that they learn better by doing, they are good at doing projects and use of materials facilitates their learning; hence, they think that their dominant learning style is kinesthetic. The other pre-service teachers; on the other hand, stated that they prefer reading loudly, they are interested in tone of voice and stresses and they learn best by listening. Moreover, these pre-service teachers stated that they like listening and speaking for a long time and as they do not forget what they have heard, they think that their dominant learning style is auditory.

Through the present study, the pre-service teachers were made aware of their own learning styles. They also understood that they can organize learning environment better when the characteristics of learning styles are known. In this way, it is believed that some contribution was made to their academic achievement and self-confidence. In addition, when pre-service teachers are knowledgeable about learning styles, they will more probably take their future students' learning styles into consideration while designing teaching environment for these students.

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http://www.westga.edu/~jdbutler/ClassNotes/learnstyles.html

Design of selected parts of non-conventional Stirling engine with FIK mechanism

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Abstract: This paper deals with a design implementation of Stirling engine with a non-conventional FIK mechanism, contains a description of its operation and discusses the possibilities of compression ratio changes. It presents the results of a research focused on individual parts of the engine, including the regenerator, FIK mechanism and heat transfer. These results have been obtained by calculation, simulation and experiments performed directly in the selected engine parts. The FLUENT software was used for the simulation.

Key words: Stirling engine, FIK, regenerator, CFD simulation

Introduction

One of many applications of the patented FIK engine construction with non-conventional mechanism with a swing plate is its modification for the Stirling engine (Kukuca et al., 2002). In this configuration, the Stirling engine uses air, which is heated in the heat cylinder of the cylinder wall and cylinder head, as a power medium.

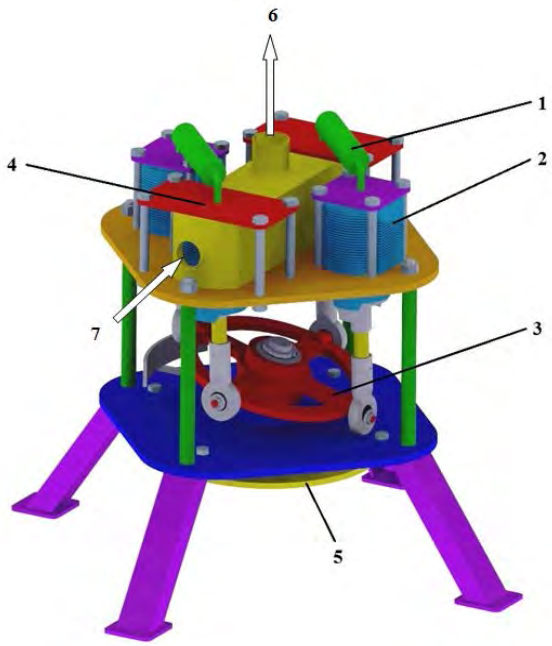

Figure 1: Virtual model of non-conventional mechanism FIK: 1 – regenerator, 2 –cooled cylinder, 3 – swing plate, 4 – heated cylinder, 5 – flywheel, 6 – heat output, 7 – heat input

Two heated and two cooled cylinders connected with a regenerator form the basic concept of the Stirling engine with the non-conventional FIK mechanism with a swing plate. The basic dimensions of the piston group were

taken from the an air-cooled vehicle engine with cylinder diameter of 75 mm and a stroke of 72 mm. When designing this engine, theoretical calculations were used. Subsequently, the proposal of the swing plate and other main engine dimensions were made. The project continued with the creation of 3D models using the Catia V5R20 software. Figure 1 shows a virtual model of non-conventional FIK mechanism. The other parts are described below.

Description of constructive units

The basic supporting structure of the engine consists of two steel plates with a thickness of 10 mm. At the top plate, there are holes for cylinders and holes for screws connection.

Figure 2: Top plate with cylinders and heads

The bottom plate performs several functions. The gearing that is there is used to assure kinematic movement of the swing plate. The bearing housings where the crankshaft is housed are there too and also the holes for fastening of the stabilization feet. The top and bottom plates are connected with four capped pipe beams with shoulder on the top. Inserting washers under the top plate can change the engine compression ratio and other performance parameters as well. The plate is screwed with four threaded rods M14.

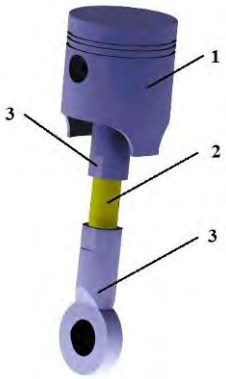

Figure 3: Piston group: 1 – piston, 2 – thread rod, 3. – rod end

The piston group of Stirling engine with non-conventional FIK mechanism was used from the air cooled

engine. The ribs of the air–cooled cylinders allow regular and steadier heating of heated cylinders in order to keep the optimal working temperature. On the other hand it allows better cooling dawn of cooled cylinders where the temperature must be stabile – isothermal.

The connecting rod of swing mechanism consists of three parts, two rod ends SKF SI 20ES and a thread rod M20, as can be seen in the figure 3. In the mechanism of the FIK engine the swing plate makes a movement in three axes. Therefore the crank bearings and piston-pin bearings use the rod ends. The rod length is variable. The designed length of connecting rod is L = 164mm (Kukuca et al., 2006).

Figure 4: Swing plate with rod ends and gear

The swing plate in the figure 4 and 5 transfers the straight-line reciprocating motion of the piston to the crankshaft. In the swing plate, there are bearing housings for conical bearing, in which the crankshaft is supported. The same type of conical bearings is used in the bottom plate.

Figure 5: Swing plate with rod ends, crankshaft, bearings and gear wheels

The position of the swing plate stabilizes the helical gearing which transmits forces on the bottom plate and defends

the rotation of the swing plate around its own axis. The design of the swing plate is letweight in order to achieve lower mass and lower inertia forces.

Figure 6: Crankshaft

The crankshaft is cranked in the angle 15° – this value was calculated. The pitch diameter of the cylinders and the piston stroke were used as the input data for calculation. The bigger pitch diameter of the cylinders, the lower crankshaft crank at the constant piston stroke. The flywheel for steady running of the engine is located in the lower end of the crankshaft. Below the flywheel, there is an engine-speed sensor.

An important part of non-conventional mechanism FIK is a balancing mechanism. Balancing equipment must secure the balance of inertia forces and moments in the engine. When this is not balanced, the participating mass makes the running around the engine axis unstable. The process of balancing depends on the mass of pistons, connecting rods, piston pins and the swing plate and on the values of basic kinematic parameters. Balancing is realized with counterweight. The counterweight is connected with the crankshaft. The radius of the counterweight arm is bigger than the radius of the swing plate. The correct position and mass of the counterweight reduce the inertia forces and moments. The values of position and mass were calculated from the input parameters. The methodology and process of calculation of FIK mechanism balancing can be found in literature (Kukuca et al., 2003, Kukuca et al., 2004).

The engine was designed for maximum operating speeds of 2000 rpm. The maximal engine power depends on the quantity of the input heat and the efficiency of the regenerator. The regenerator consists of the body and the filling. Figure 7 shows the cut of engine.

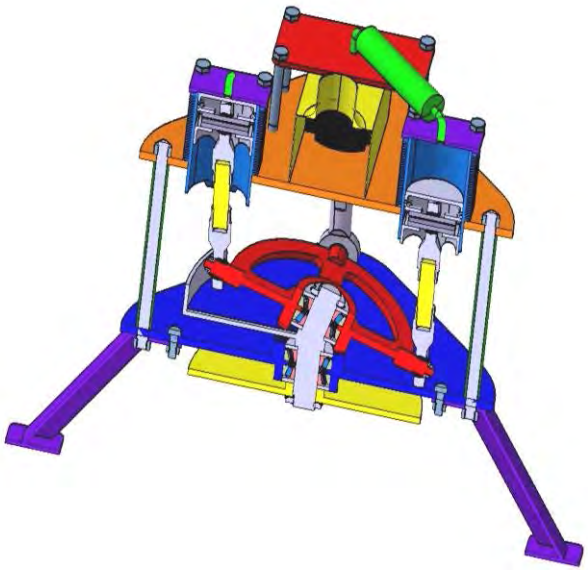

Figure 7: Cut of the engine

Working principle

Both heated cylinders are heated from outside with directed flow of heat air from two independent hot-air devices. The parameters of hot-air devices are: performance 2000W, air flow 650l/min and temperature of heated air from 50 to 600°C. Also other sources of heat can be used for heating, for example, a gas-jet. For directing the flow of hot air around the heated cylinder walls was designed the cylinders sheathing. The limiting factor of heating the cylinders is the temperature at the internal wall of the cylinder, due to the maintaining of lubricating properties of oil. The oil could not go over 240°C. The cooled and heated cylinders are connected with the regenerator by pipes. The phase shift between the pistons in heated and cooled cylinders is 90°. In order to achieve the highest thermal stability in the cylinders, the highest engine efficiency and performance and the best heat utilization, the engine design includes the heat regenerator.

Regenerator

The basic requirement for the regenerator is to capture the maximum amount of heat contained in the air as a working medium when the heated air is moving from the heated cylinder to the cooled cylinder and then to reabsorb it when the cooled air is moving from the cooled cylinder to the heated cylinder.
It is therefore necessary to propose a regenerator with a space large enough and with a reasonable volume, lowering the final compression engine ratio (Bigos, Puskar, 2008). The first regenerator concept showed the need to synchronize its size and the engine speed.

The simulation of regenerator work was made by Fluent software (Sojcak et al., 2005).

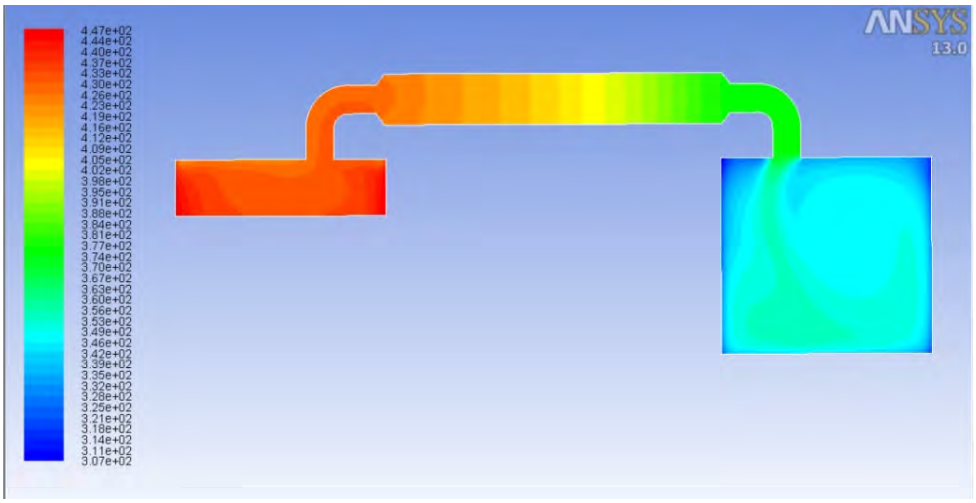

Figure 8: Distribution of temperatures in the cylinders and regenerator - porosity 0.961

Program Fluent use these main steps of CFD analysis:

- the basic formulation of the task (problem definition),
- creating a geometric model and the control area (use of CAD system),
- creating boundary and initial conditions,
- set the correct physical model with regards to the studied problem,
- creation and generation of adequate mesh (structure, size, or local concentration),
- CFD calculation (the assessment of convergence solution, eventually review of model parameters),
- data processing to obtain results,
- comparison with other results (experimental when available),
- critical evaluation of the obtained results.

In this case was used a standard turbulence k – ε model. This model is simplest "complete model" of turbulence with two-equation models in which the solution of two separate transport equations allows the turbulent velocity and length scales to be independently determined. The k - ε standard model in FLUENT software falls within this class of turbulence model and has become the workhorse of practical engineering flow calculations in the time since it was proposed by Launder and Spalding. Robustness, economy, and reasonable accuracy for a wide range of turbulent flows explain its popularity in industrial flow and heat transfer simulations.

For our problem was created 2D geometry of cylinders, pipes and regenerator in Catia software. Sketch was exported as a step file to the Gambit program, which is used to computing grid creating.

Results of 2D simulations showed the problems which must be solved in 3D simulation. It was found how the geometry of the regenerator inlet and outlet sections influences flow in the regenerator and how to determine the regenerator volume to avoid an excessive heating of the medium in the cold cylinder as seen in the figure 8. 2D simulation showed also how the porosity and material of regenerator filling influences the function of regenerator.

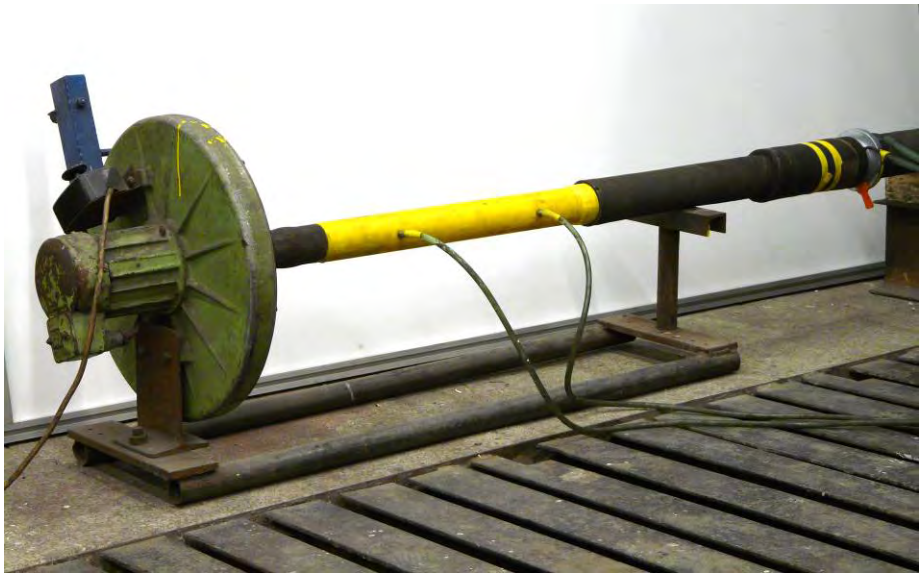

Figure 9: Measuring equipment for measurement of flow resistance in regenerator

It is necessary to know the flow resistance values caused by regenerator filling to get more accurate simulation calculations in 3D geometry. These values are in figure 11 and they were obtained by real measurement on the test model shown in figure 9. Coefficients C_2 and $1/\alpha$ determining the regenerator filling properties were calculated from the values of flow resistance as follows:

Experimental data that is available in the form of pressure drop against velocity through the porous component, can be extrapolated to determine the coefficients for the porous media

Then a p-v curve can be plotted to create a trend line through these points yielding the following equation

$$\Delta p = 11{,}592v2 + 7E\text{-}13v$$

where Δp is the pressure drop and v is the velocity.

For the coefficients we can write

$$11{,}592 = C_2 \frac{1}{2} \rho \Delta n$$

with ρ=1,1845 kg/m3 at 25° Celsius, porous media thickness Δn = 0,19 m, inertial resistance factor

$$C_2 = 103$$

$$7.10^{-13} = \frac{\mu}{\alpha}\Delta n$$

with air kinematic viscosity μ = 1,56E-5 m2/s, the viscous inertial resistance factor

$$\frac{1}{\alpha} = 2{,}3616^{-7}$$

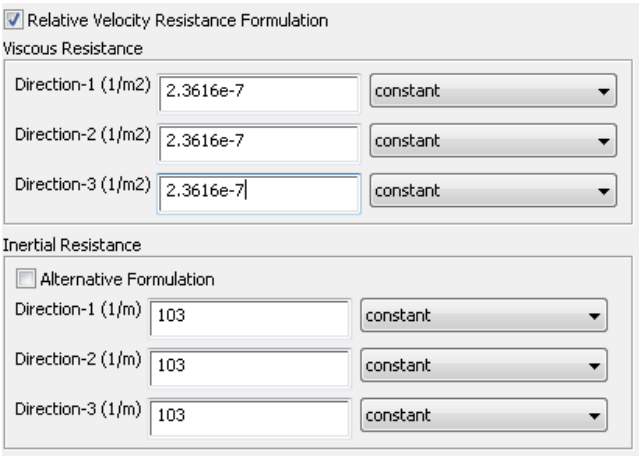

Figure 10: Formulation of porous media coefficients in Fluent software

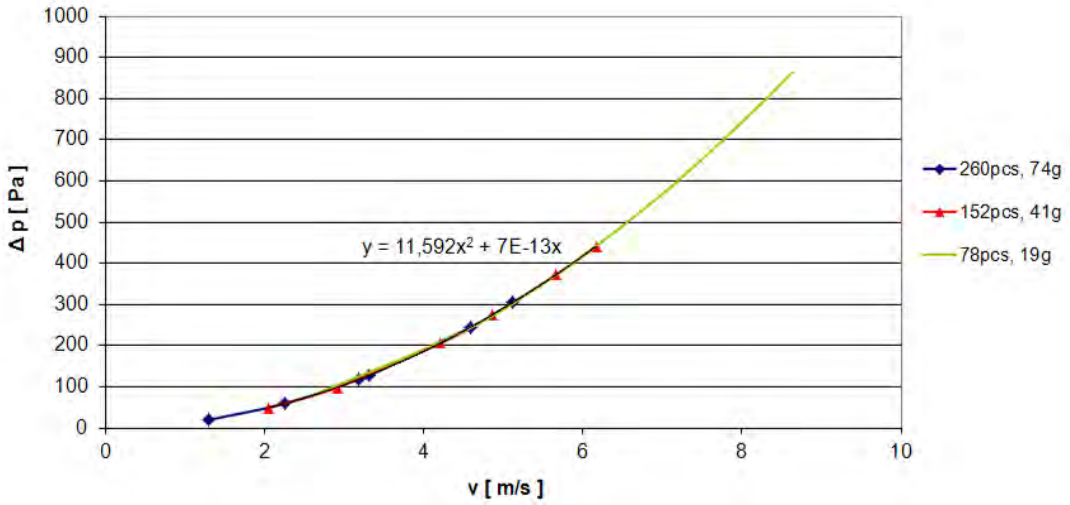

Figure 11: Measuring equipment for measurement of flow resistance in regenerator

Cylinders

It is important to put a maximum of input heat in the shortest time. The heat transfer through the cylinder wall and ribs was simulated. To avoid the local overheating of the cylinder from the source of hot air, the deflector, which directs the hot air flow around the cylinders, had to be used. To ensure the flow of the air through the cylinder ribs and more even distribution of temperature on the whole surface of the cylinder the sheathing with a minimum gap (1mm) between the cylinder ribs and sheathing was designed. Figure 12 shows the airflow around the cylinder and its

guidance to hot air exhaust.

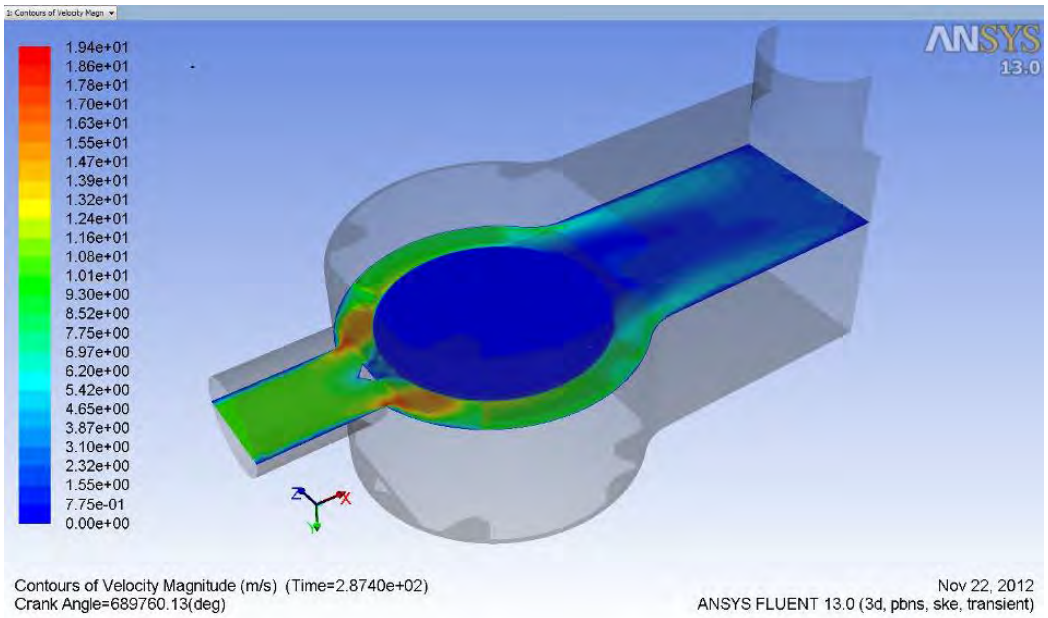

Figure 12: The course of velocity of hot air flowing between the cylinder ribs

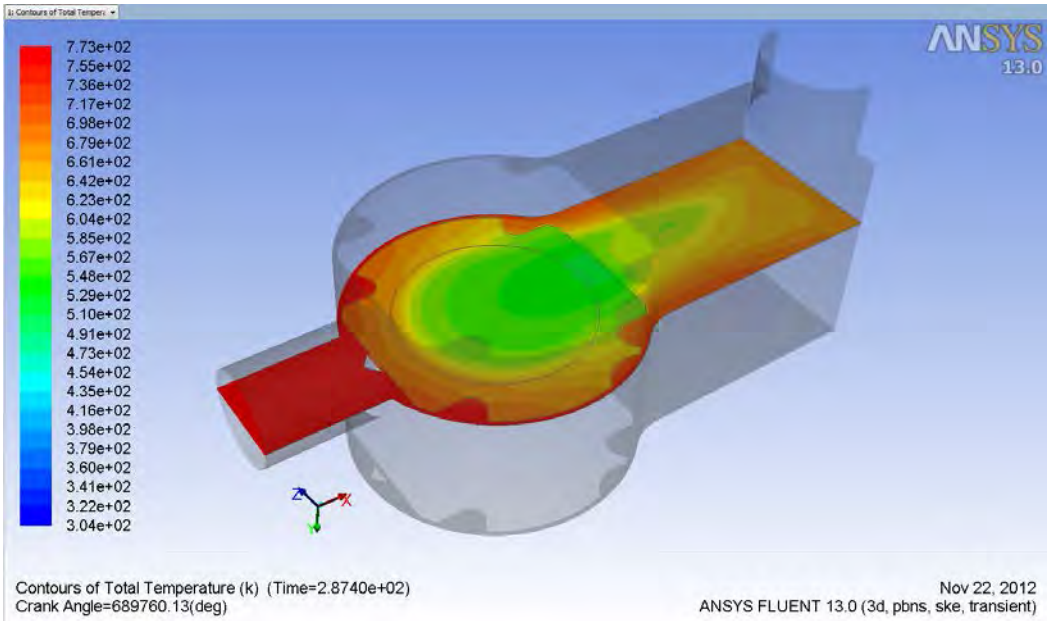

Figure 13: The course of temperatures of heated air and the cylinder through the ribs

As seen in the figure 13, about 65% of the cylinder surface flowed around by hot air reaches approximately identical temperature, about 680 K. The lowest temperature is achieved on the back of the heated cylinder, approximately 540 K, what is quite significant temperature difference.

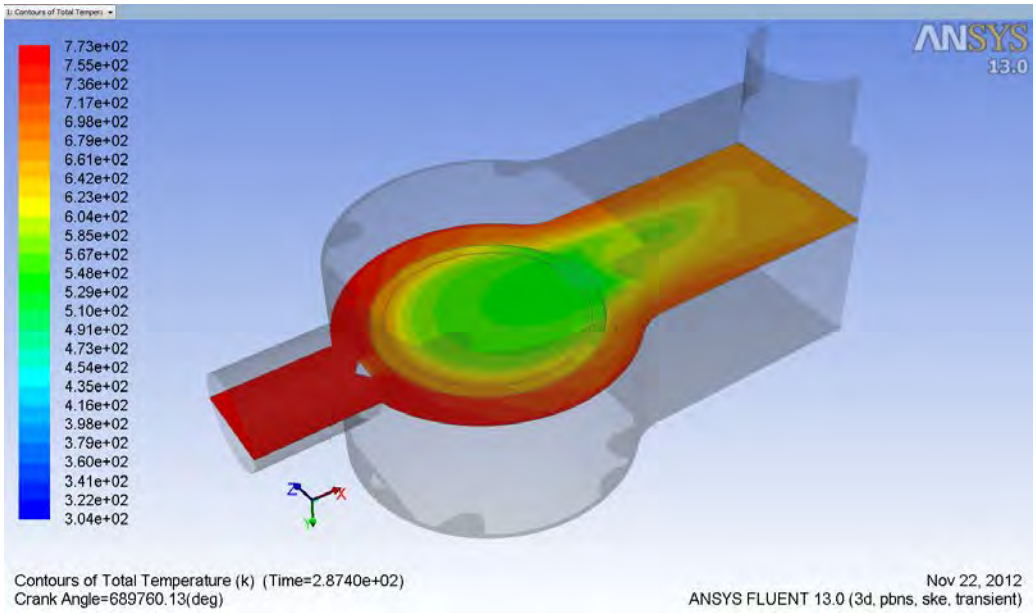

Figure 14: The course of temperatures of heated air and the cylinder through the volume between the ribs.

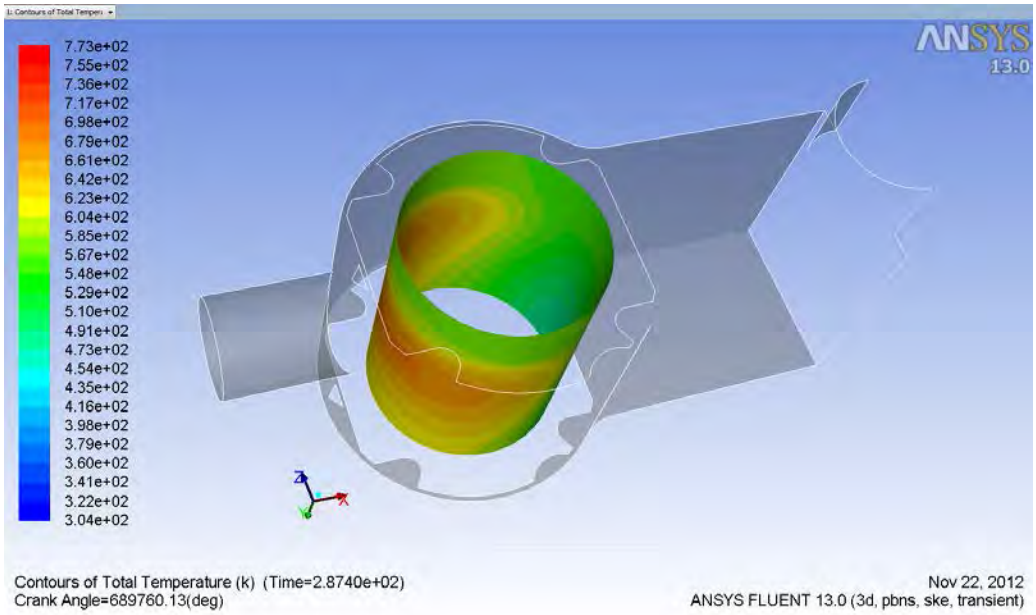

Figure 15: The course of temperatures inside the heated cylinder

As seen in figure 15, which shows the inner surfaces of the cylinder, the back part of the cylinder where miss the sheathing and guidance the flow of hot air remain significantly cooler. Because the sheathing is common for both heated cylinders the simulation was solved as symmetrical. The simulation showed that the designed shape of sheathing can not ensure more even heating of the cylinder on the whole surface and that the hot air flowing the opposite cylinder do not cause sufficient change of the flow in the area between the cylinder and the air outlet of the sheathing. As a result, the hot air will be not guidance on the back of the heating cylinder. To achieve better temperature distribution on the cylinder surface will be necessary to modify the sheathing form and to verify it by next simulations.

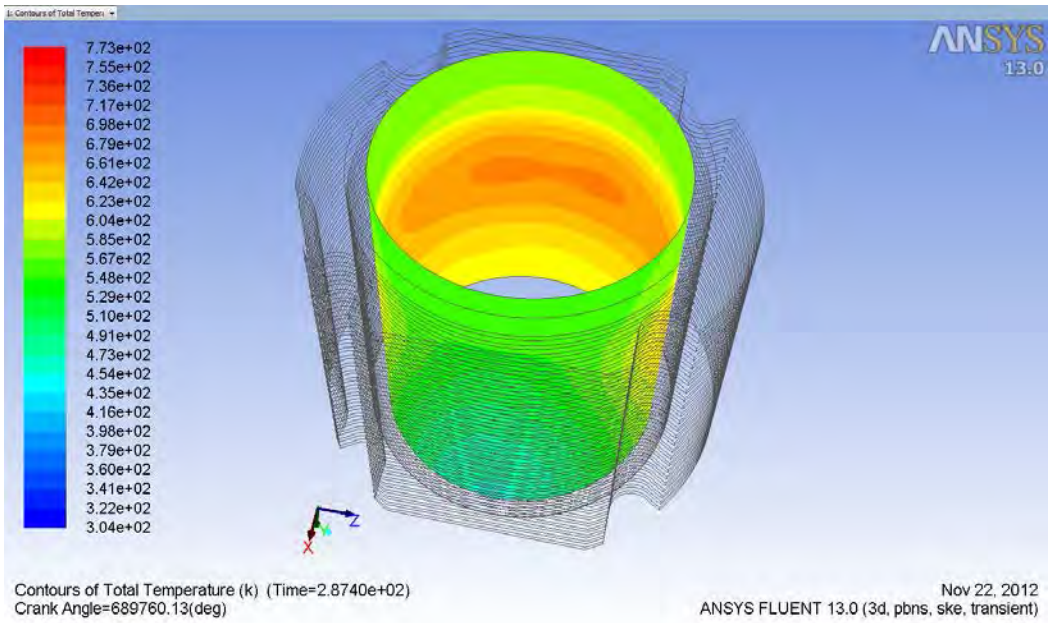

Figure 16: The course of temperatures inside the heated cylinder with ribbing

Figure 17 shows the heating of the cylinder and piston in the current position in top dead center. The simulation was performed at a moving piston and speed 400 min^{-1}.

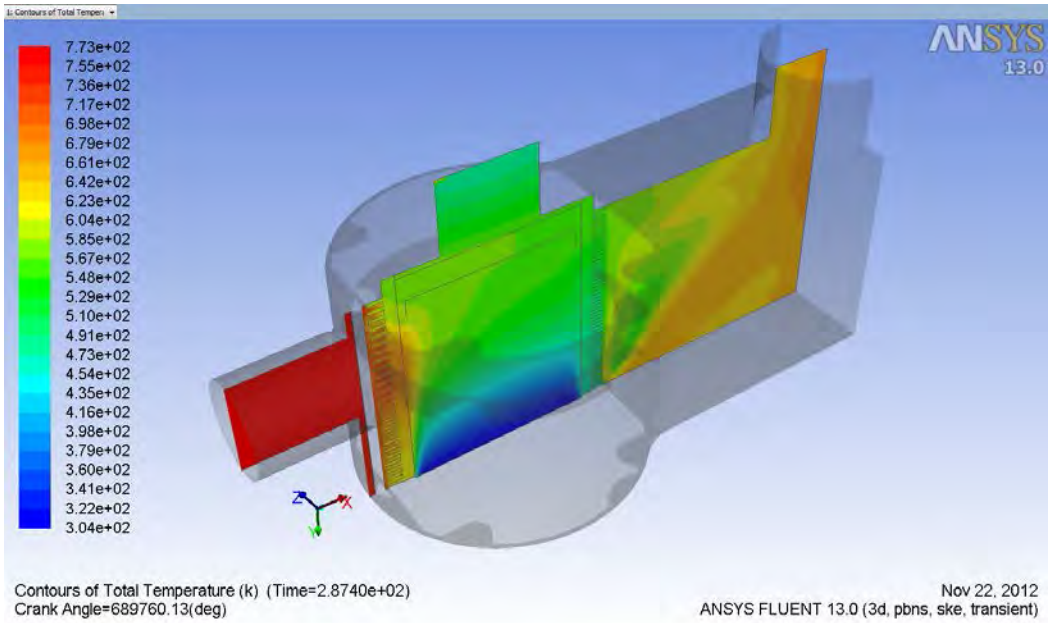

Figure 17: The course of temperatures in the cross-section of heated cylinder with ribbing

Conclusions

The design of the non-conventional Stirling engine with the FIK mechanism was created as a part of the VEGA 1/0763/11 project. The paper describes the current state of the project. The project's goal is the construction of a functional engine. The engine parts that are already available are shown in the figures above. Simulations by the Fluent software were used when designing some heat-affected parts such as the regenerator, cylinders, cylinder sheathing . The regenerator Simulations showed a need to modify some regenerator parts to improve the flow and to ensure a sufficient regenerator output. It will be needed to perform a 3D simulation of the real state with accurate computation input conditions.

Laboratory measurements of the flow resistance for a specific regenerator type that were taken will be used in a 3D model simulation calculation. The determination of the heat input for the Stirling engine function was another task of the solution. That was based on the heat transfer simulation calculations for the heated engine cylinder with the optimal airflow of heating medium – hot air coming from heat guns through the cylinder ribs. The calculations showed insufficient heating of the cylinder back on approximately 35% of its circumference even when the hot air flow from another heated cylinder was taken into account.

Acknowledgements

This contribution was created within the framework of the project VEGA 1/0763/11, which is supported by the Ministry of Education of the Slovak Republic.

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Sakarya University Online Academic Systems

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Abstract: Nowadays, everything is changed; every person and system keeps pace with the innovation. Starting from here, with the innovation and development of technologies this study aims to explain online systems. Moreover examples of online academic systems are shown. These systems belong to Sakarya University and now every system is alive. These systems facilitate the students and staffs lives with providing opportunities to manage and use online academic systems easily and affectively.

Keywords: Online Academic Systems, Performance System

Introduction

Communication technologies have developed very fast. This development has affect education system. For example, performance system has changed with internet. Academicians can see their performance system on internet.

Performance systems are important for academicians and staff in universities. These help for facilitating the life in order to manage all activities in universities. Thus this increases the performance of academicians and staff in their duty. With the innovation and development of technologies, performance systems are electronic and online now.

Inside of the innovation and rapidly developed technology, a complex workflow is included. Performance system is reducing the workload of academicians and staff. Performance systems to be online with the developing technology are another factor in making our lives easier. Furthermore these systems simplify maintenance, processes, choices, implementation and delivery. Besides these, performance systems strengthen communication and computer infrastructure, knowledge base, facilitate knowledge management and increase usability (Maughan, 2005).

Traditional systems cannot sufficiently prepare academicians and staff for today's complex workplace. Thus new and more effectively systems are needed. With this need, in order to achieve a successful performance, and to increase productivity information technologies are used (Lee and Lui, 2006; Gottfredson and Mosher, 2010).

Figure 1. Sakarya University's Web Site Home Page

Thanks to its strong communications infrastructure and knowledge base, Sakarya University aims to provide information technology services to students and staff. Sakarya University has different information technology systems for managing and increasing the performance. These systems are:

- Sakarya University Academic Information System (Sakarya Üniversitesi Akademik Bilgi Sistemi-SABİS)
- Educational Information System (Eğitim Öğretim Bilgi Sistemi- EBS)
- Strategic Management Information System (Stratejik Yönetim Bilgi Sistemi- SYBS)
- Sakarya University Campus Automation Web Information System (CAWİS)

Sakarya University Academic Information System - SABİS

Sakarya University Academic Information System (Sakarya Üniversitesi Akademik Bilgi Sistemi-SABİS) is a new system and its web site is http://www.sabis.sakarya.edu.tr/ . In this system, it is aimed to manage the academic activities for academicians. Moreover for guest users SABİS offer the chance to look at the course programs, contents and teaching staff.

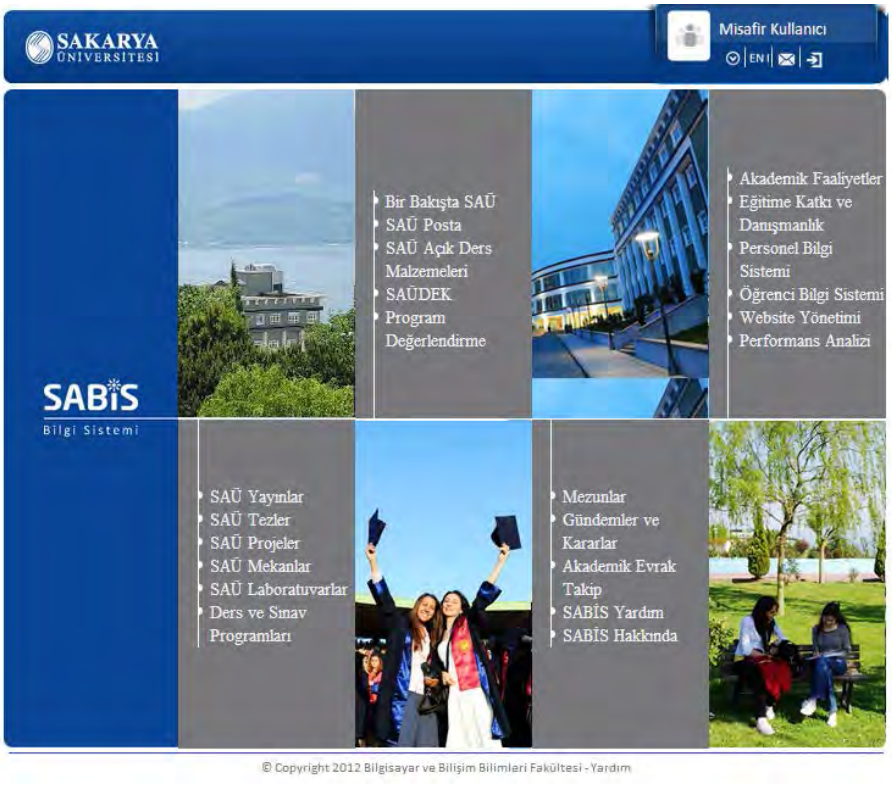


Figure 2. Sakarya University Academic Information System - SABİS

With SABİS, it is accessed to open course materials, the Sakarya University Academic Evaluation and Quality Improvement Committee (SAkarya Üniversitesi Akademik DEğerlendirme ve Kalite Geliştirme Kurulu-SAÜDEK) decisions, academic activities, consultancy services, personal information services, student information services, website management, performance analyses, Sakarya University publications, thesis, projects, locations, laboratories, course and exam programs, graduates system, agendas and decisions, academic documents tracking system. On the other hand SABİS permit the university staff access their mail from this site.

Figure 3. SABİS Mail Service User Login

In SABİS from the part of the website management, there is access and management panel for web sites which is haven by each university staff, each academic and administrative unit on behalf of institutional identity.

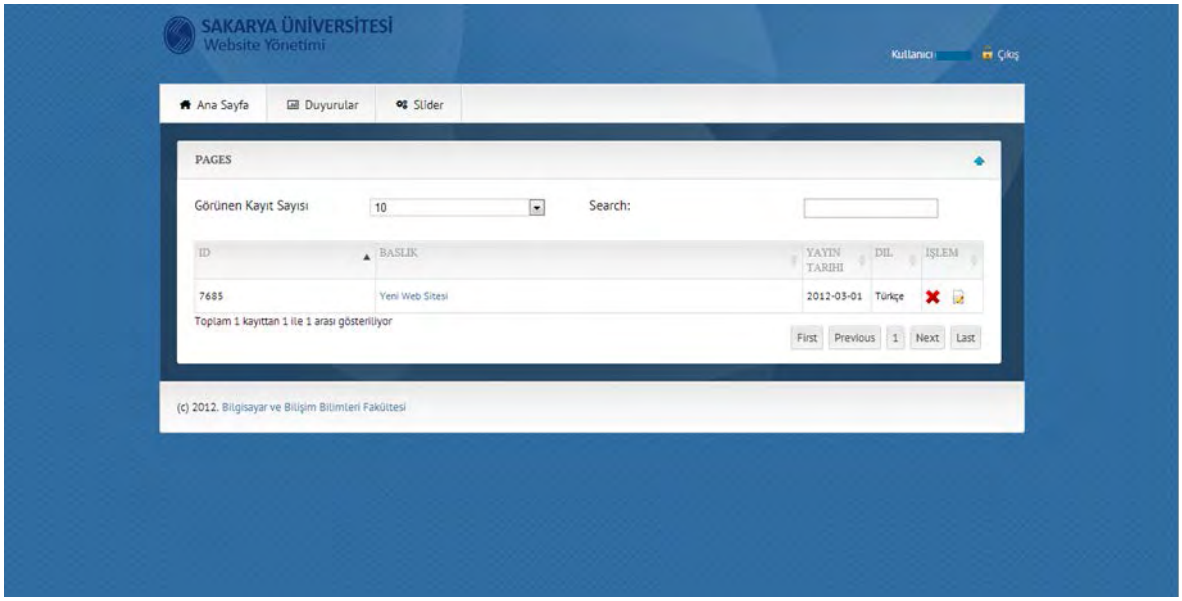


Figure 4. SABİS Web Site Management

Educational Information System - EIS

The mission of Sakarya University is to maintain a contemporary academic tradition that enhances and produces information and technology at universal standards and to be keen on research, to be participative, sharing and innovative and appreciative of aesthetic values. For this mission, Sakarya University founded different systems like (Educational Information System).

Bologna Process urges all EU higher education institutions to evaluate competencies of their educational programs and to maintain a common perception of quality. Through EIS (Educational Information System), Sakarya University aims at describing its curricular activities within a constantly evolving and transparent framework. What makes EIS a remarkable software is its integrity and compatibility with Sakarya University's other information systems that are currently operating.

EIS includes documents regarding university's academic program competencies and objectives, lesson plans, relations between courses and program competencies, course outcome, evaluation criteria, documents for teaching staff to share, questionnaires evaluating educational processes, in-service training documents for the initiative of updating educational programs that commenced in December 27, 2007. EIS contains 9.223 different described courses that are still being processed.

Figure 5. Sakarya University Educational Information System

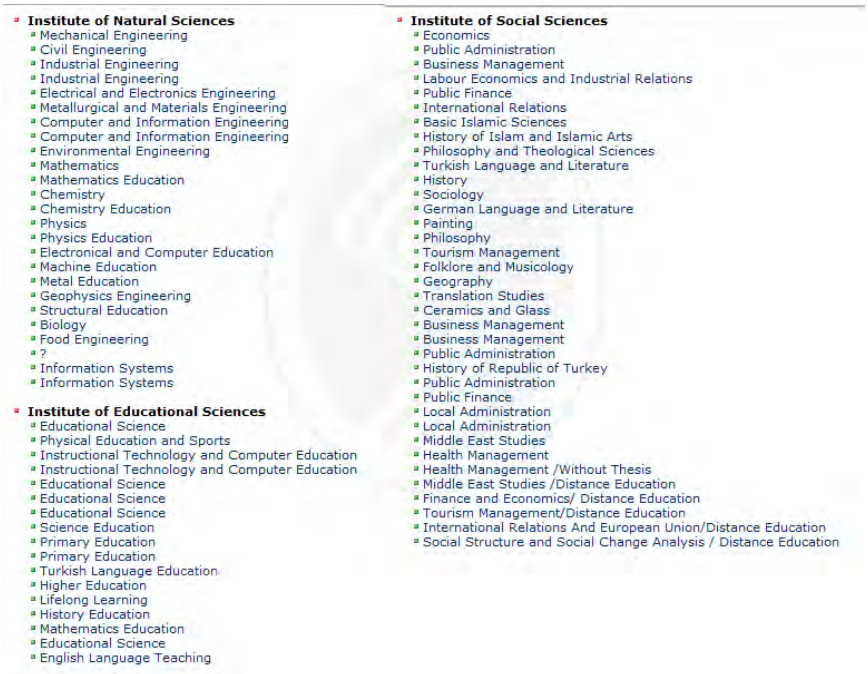
Degree Programmes:

Doctorate Degree (Third Cycle Programmes)

- **Institute of Natural Sciences**
  - Mechanical Engineering
  - Civil Engineering
  - Industrial Engineering
  - Electrical and Electronics Engineering
  - Metallurgical and Materials Engineering
  - Computer and Information Engineering
  - Environmental Engineering
  - Mathematics
  - Chemistry
  - Physics
  - Electronical and Computer Education
  - Machine Education
  - Metal Education
  - Geophysics Engineering
  - Biology
- **Institute of Educational Sciences**
  - Physical Education and Sports
  - Instructional Technology and Computer Education
  - Educational Science
  - Science Education
  - Turkish Language Education
- **Institute of Social Sciences**
  - Economics
  - Public Administration
  - Business Management
  - Labour Economics and Industrial Relations
  - Public Finance
  - International Relations
  - Basic Islamic Sciences
  - History of Islam and Islamic Arts
  - Philosophy and Theological Sciences
  - Turkish Language and Literature
  - History
  - Sociology
  - German Language and Literature
  - Philosophy
  - Tourism Management
  - Interpretation and Translation

Figure 6. Sakarya University Doctorate Degree (Third Cycle Programmes)

Master's Degree (Second Cycle Programmes)



- **Institute of Natural Sciences**
  - Mechanical Engineering
  - Civil Engineering
  - Industrial Engineering
  - Industrial Engineering
  - Electrical and Electronics Engineering
  - Metallurgical and Materials Engineering
  - Computer and Information Engineering
  - Computer and Information Engineering
  - Environmental Engineering
  - Mathematics
  - Mathematics Education
  - Chemistry
  - Chemistry Education
  - Physics
  - Physics Education
  - Electronical and Computer Education
  - Machine Education
  - Metal Education
  - Geophysics Engineering
  - Structural Education
  - Biology
  - Food Engineering
  - ?
  - Information Systems
  - Information Systems
- **Institute of Educational Sciences**
  - Educational Science
  - Physical Education and Sports
  - Instructional Technology and Computer Education
  - Instructional Technology and Computer Education
  - Educational Science
  - Educational Science
  - Educational Science
  - Science Education
  - Primary Education
  - Primary Education
  - Turkish Language Education
  - Higher Education
  - Lifelong Learning
  - History Education
  - Mathematics Education
  - Educational Science
  - English Language Teaching
- **Institute of Social Sciences**
  - Economics
  - Public Administration
  - Business Management
  - Labour Economics and Industrial Relations
  - Public Finance
  - International Relations
  - Basic Islamic Sciences
  - History of Islam and Islamic Arts
  - Philosophy and Theological Sciences
  - Turkish Language and Literature
  - History
  - Sociology
  - German Language and Literature
  - Painting
  - Philosophy
  - Tourism Management
  - Folklore and Musicology
  - Geography
  - Translation Studies
  - Ceramics and Glass
  - Business Management
  - Business Management
  - Public Administration
  - History of Republic of Turkey
  - Public Administration
  - Public Finance
  - Local Administration
  - Local Administration
  - Middle East Studies
  - Health Management
  - Health Management /Without Thesis
  - Middle East Studies /Distance Education
  - Finance and Economics/ Distance Education
  - Tourism Management/Distance Education
  - International Relations And European Union/Distance Education
  - Social Structure and Social Change Analysis / Distance Education

Figure 7. Sakarya University Master's Degree (Second Cycle Programmes)

Bachelor's Degree (First Cycle Programmes)

Figure 8. Sakarya University Bachelor's Degree (First Cycle Programmes)

Associate's Degree (Short Cycle Programmes)

Figure 9. Sakarya University Associate's Degree (Short Cycle Programmes)

Any part of these programs lesson plan, curriculum, course content, documents can be accessed from EIS.

For example, if Bachelor's Degree (First Cycle Programmes), Faculty of Education, Department of Instructional Technology and Computer Education is chosen, menus of Goals & Objectives, Program Learning Outcomes, Teaching & Learning Methods, Course Struct.&ECTS Credits, Course&Program L. Outcomes, Course Categories, Level of Qualification, Admission Requirements, Occupational Profiles, Graduation Requirements, Assessment and Grading, Prog. Director & ECTS Coord., Polls Applied to Students are seen.

Goals & Objectives

Figure 10. Goals & Objectives

Program Learning Outcomes

Program learning outcomes may be displayed with classified, list or cycle/field/program format.

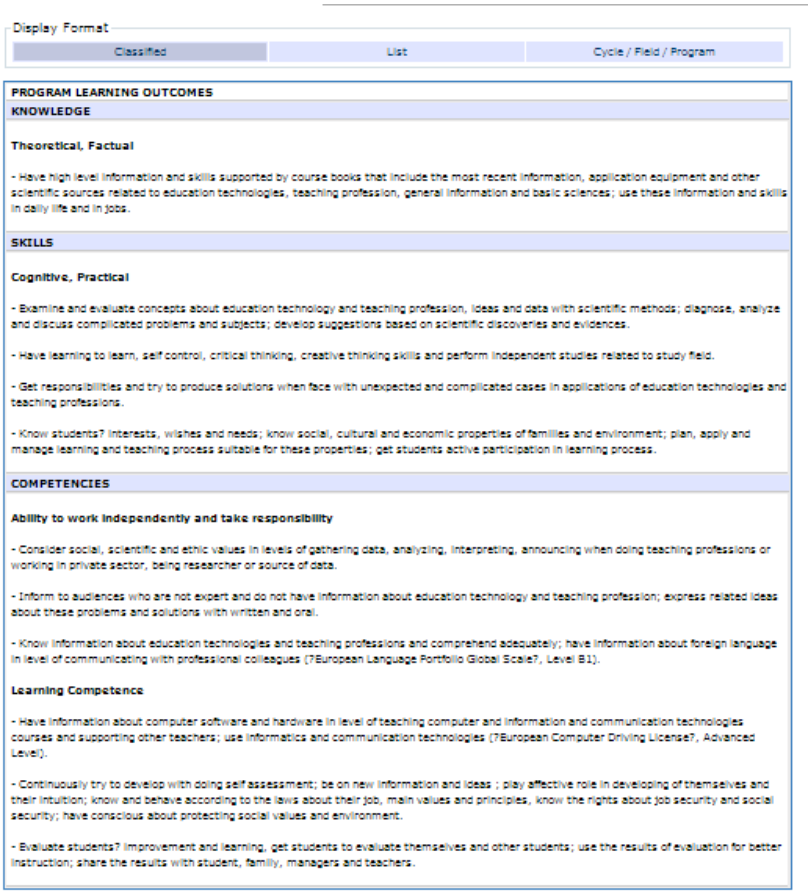
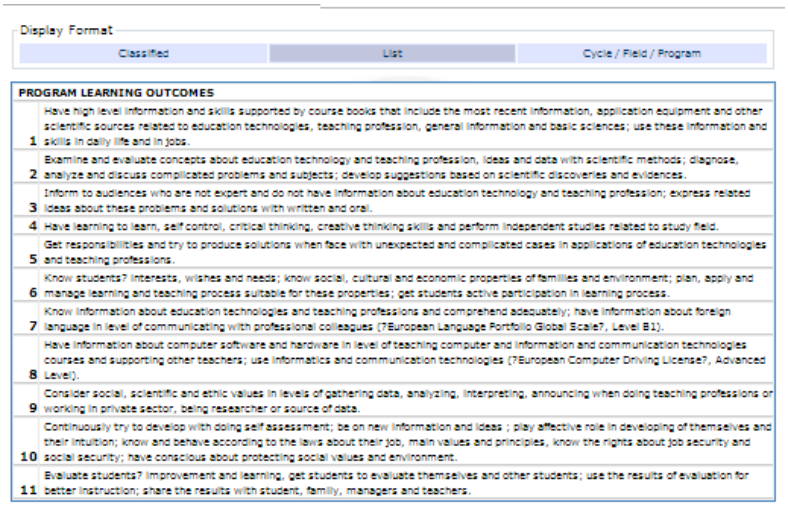


Figure 11. Program Learning Outcomes Classified Display Format

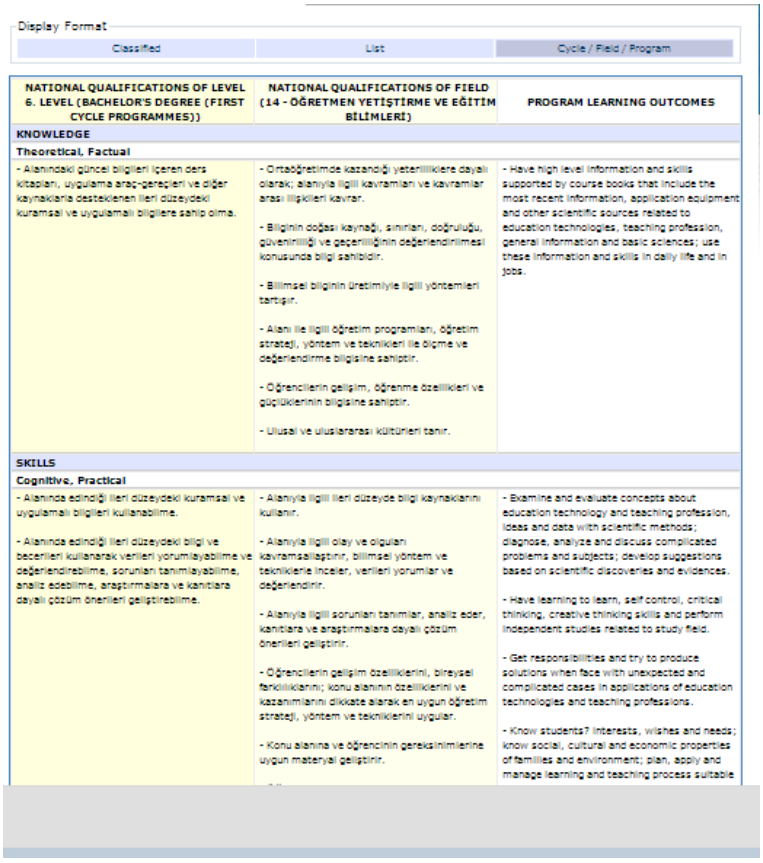


Display Format

Classified | List | Cycle / Field / Program

	PROGRAM LEARNING OUTCOMES
1	Have high level information and skills supported by course books that include the most recent information, application equipment and other scientific sources related to education technologies, teaching profession, general information and basic sciences; use these information and skills in daily life and in jobs.
2	Examine and evaluate concepts about education technology and teaching profession, ideas and data with scientific methods; diagnose, analyze and discuss complicated problems and subjects; develop suggestions based on scientific discoveries and evidences.
3	Inform to audiences who are not expert and do not have information about education technology and teaching profession; express related ideas about these problems and solutions with written and oral.
4	Have learning to learn, self control, critical thinking, creative thinking skills and perform independent studies related to study field.
5	Get responsibilities and try to produce solutions when face with unexpected and complicated cases in applications of education technologies and teaching professions.
6	Know students? interests, wishes and needs; know social, cultural and economic properties of families and environment; plan, apply and manage learning and teaching process suitable for these properties; get students active participation in learning process.
7	Know information about education technologies and teaching professions and comprehend adequately; have information about foreign language in level of communicating with professional colleagues (?European Language Portfolio Global Scale?, Level B1).
8	Have information about computer software and hardware in level of teaching computer and information and communication technologies courses and supporting other teachers; use informatics and communication technologies (?European Computer Driving License?, Advanced Level).
9	Consider social, scientific and ethic values in levels of gathering data, analyzing, interpreting, announcing when doing teaching professions or working in private sector, being researcher or source of data.
10	Continuously try to develop with doing self assessment; be on new information and ideas ; play affective role in developing of themselves and their institution; know and behave according to the laws about their job, main values and principles, know the rights about job security and social security; have conscious about protecting social values and environment.
11	Evaluate students? improvement and learning, get students to evaluate themselves and other students; use the results of evaluation for better instruction; share the results with student, family, managers and teachers.

Figure 12. Program Learning Outcomes List Display Format



Display Format

Classified | List | Cycle / Field / Program

NATIONAL QUALIFICATIONS OF LEVEL 6. LEVEL (BACHELOR'S DEGREE (FIRST CYCLE PROGRAMMES))	NATIONAL QUALIFICATIONS OF FIELD (14 - ÖĞRETMEN YETİŞTİRME VE EĞİTİM BİLİMLERİ)	PROGRAM LEARNING OUTCOMES
KNOWLEDGE		
Theoretical, Factual		
- Alanındaki güncel bilgileri içeren ders kitapları, uygulama araç-gereçleri ve diğer kaynaklarla desteklenen ileri düzeydeki kuramsal ve uygulamalı bilgilere sahip olma.	- Ortaöğretimde kazandığı yeterliliklere dayalı olarak; alanıyla ilgili kavramları ve kavramlar arası ilişkileri kavrar. - Bilginin doğası kaynağı, sınırları, doğruluğu, güvenirliliği ve geçerliliğinin değerlendirilmesi konusunda bilgi sahibidir. - Bilimsel bilginin üretimiyle ilgili yöntemleri tartışır. - Alanı ile ilgili öğretim programları, öğretim strateji, yöntem ve teknikleri ile ölçme ve değerlendirme bilgisine sahiptir. - Öğrencilerin gelişim, öğrenme özellikleri ve güçlüklerinin bilgisine sahiptir. - Ulusal ve uluslararası kültürleri tanır.	- Have high level information and skills supported by course books that include the most recent information, application equipment and other scientific sources related to education technologies, teaching profession, general information and basic sciences; use these information and skills in daily life and in jobs.
SKILLS		
Cognitive, Practical		
- Alanında edindiği ileri düzeydeki kuramsal ve uygulamalı bilgileri kullanabilme. - Alanında edindiği ileri düzeydeki bilgi ve becerileri kullanarak verileri yorumlayabilme ve değerlendirebilme, sorunları tanımlayabilme, analiz edebilme, araştırmalara ve kanıtlara dayalı çözüm önerileri geliştirebilme.	- Alanıyla ilgili ileri düzeyde bilgi kaynaklarını kullanır. - Alanıyla ilgili olay ve olguları kavramsallaştırır, bilimsel yöntem ve tekniklerle inceler, verileri yorumlar ve değerlendirir. - Alanıyla ilgili sorunları tanımlar, analiz eder, kanıtlara ve araştırmalara dayalı çözüm önerileri geliştirir. - Öğrencilerin gelişim özelliklerini, bireysel farklılıklarını; konu alanının özelliklerini ve kazanımlarını dikkate alarak en uygun öğretim strateji, yöntem ve tekniklerini uygular. - Konu alanına ve öğrencinin gereksinimlerine uygun materyal geliştirir.	- Examine and evaluate concepts about education technology and teaching profession, ideas and data with scientific methods; diagnose, analyze and discuss complicated problems and subjects; develop suggestions based on scientific discoveries and evidences. - Have learning to learn, self control, critical thinking, creative thinking skills and perform independent studies related to study field. - Get responsibilities and try to produce solutions when face with unexpected and complicated cases in applications of education technologies and teaching professions. - Know students? interests, wishes and needs; know social, cultural and economic properties of families and environment; plan, apply and manage learning and teaching process suitable

Figure 13. Program Learning Outcomes Cycle/Field/Program Display Format

Teaching & Learning Methods

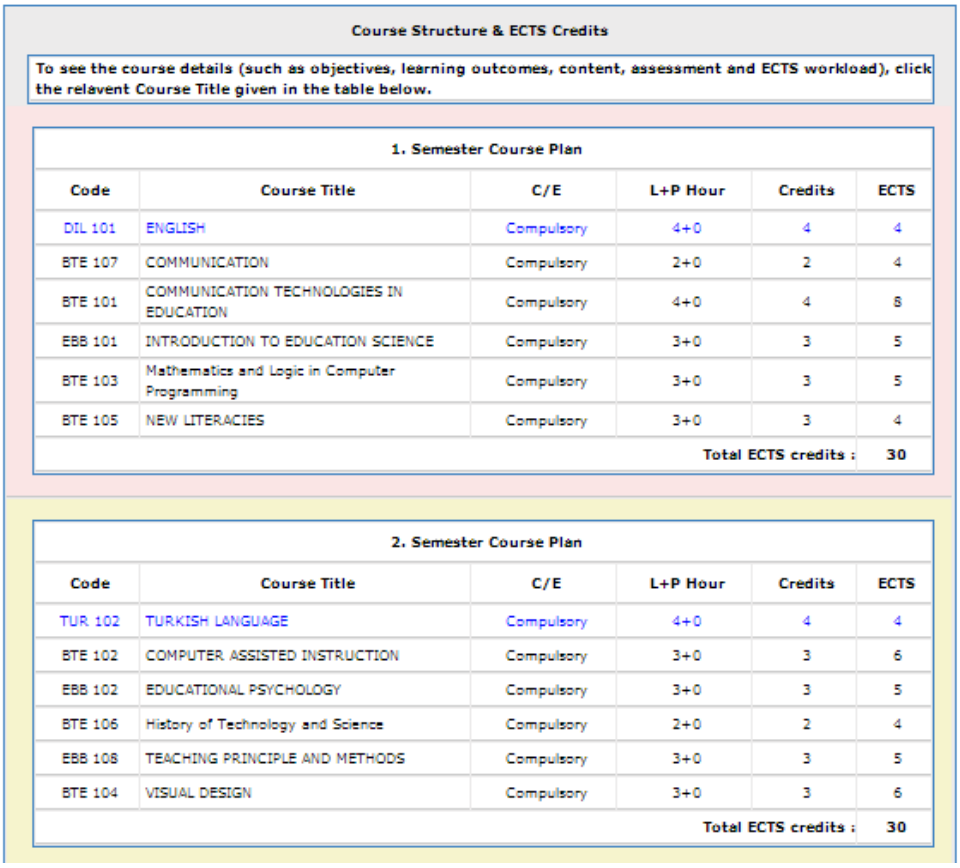
Teaching and learning methods and strategies are chosen to improve the student's skills such as self learning, life-long learning, observation, teaching others, presentation, critical thinking, teamworking and IT.

Also, to achieve a better learning with students having different learning styles, the program is supported by convenient methodologies.

Teaching and Learning Methods	Major Learning Activities	Tools
Lecture	Listening and interpretation	Classware, multimedia, data projector, computer, overhead projector
Lecture with Discussion	Listening and interpretation, Observation/manipulation situations, critical thinking, question posing	Classware, multimedia, data projector, computer, overhead projector
Tutorial / Structured Exercise	Specific predetermined skill	
Role Play	Specific predetermined skill	Classware, specific hardware
Problem Solving	Specific predetermined skill	
Case Study	Specific predetermined skill	
Brainstorming	Observation/manipulation situations, critical thinking, question posing, creative teamwork	
Small Group Discussion	Listening and interpretation, Observation/manipulation situations, critical thinking, question posing	Classware, Multimedia, data projector, computer, overhead projector
Demonstration	Observation/manipulation situations	Tools that allow observation followed by virtual application
Simulation	Observation/manipulation situations, IT Skills	Tools that allow observation followed by virtual application
Seminars	Research skills, writing, reading, IT Skills, Listening and interpretation, Observation/manipulation situations, organizational skills	Classware, multimedia, data projector, computer, overhead projector, specific hardware
Group work	Research skills, writing, reading, IT Skills, critical thinking, question posing, organizational skills, teamwork	Web directories, database, e-mail, online discussion, web-based discussion forums
Fieldwork	Observation/manipulation situations, Research skills, writing, reading	
Laboratory	Observation/manipulation situations, IT Skills, organizational skills, teamwork	Specific hardware
Homework	Research skills, writing, reading, IT Skills	Web directories, database, e-mail
Recitation	Research skills, manipulation situations, question posing, interpretation, presentation	
Worksheets/Surveys	Research skills, writing, reading	
Panel of Experts	Listening and interpretation, Observation/manipulation situations	Classware, multimedia, data projector, computer, overhead projector, specific hardware
Guest Speaker	Listening and interpretation, Observation/manipulation situations	Classware, multimedia, data projector, computer, overhead projector, specific hardware
Student Club Activities / Projects	Observation/manipulation situations, critical thinking, question posing, creative team work, Research skills, organizational skills, writing, reading, specific predetermined skill	

Figure 14. Teaching & Learning Methods

Course Structure & ECTS Credits



Course Structure & ECTS Credits

To see the course details (such as objectives, learning outcomes, content, assessment and ECTS workload), click the relavent Course Title given in the table below.

1. Semester Course Plan

Code	Course Title	C/E	L+P Hour	Credits	ECTS
DIL 101	ENGLISH	Compulsory	4+0	4	4
BTE 107	COMMUNICATION	Compulsory	2+0	2	4
BTE 101	COMMUNICATION TECHNOLOGIES IN EDUCATION	Compulsory	4+0	4	8
EBB 101	INTRODUCTION TO EDUCATION SCIENCE	Compulsory	3+0	3	5
BTE 103	Mathematics and Logic in Computer Programming	Compulsory	3+0	3	5
BTE 105	NEW LITERACIES	Compulsory	3+0	3	4
				Total ECTS credits :	30

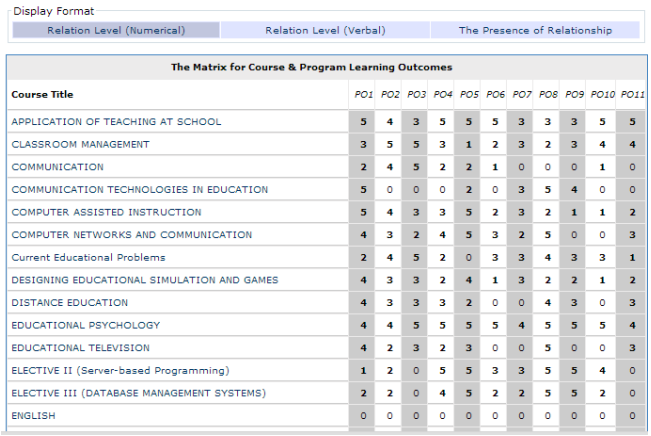
2. Semester Course Plan

Code	Course Title	C/E	L+P Hour	Credits	ECTS
TUR 102	TURKISH LANGUAGE	Compulsory	4+0	4	4
BTE 102	COMPUTER ASSISTED INSTRUCTION	Compulsory	3+0	3	6
EBB 102	EDUCATIONAL PSYCHOLOGY	Compulsory	3+0	3	5
BTE 106	History of Technology and Science	Compulsory	2+0	2	4
EBB 108	TEACHING PRINCIPLE AND METHODS	Compulsory	3+0	3	5
BTE 104	VISUAL DESIGN	Compulsory	3+0	3	6
				Total ECTS credits :	30

Figure 15. Course Structure & ECTS Credits

Course & Program Learning Outcomes

Course&Program L. Outcomes may be displayed with numerical relation level, verbal relation level or the presence of relationship format.

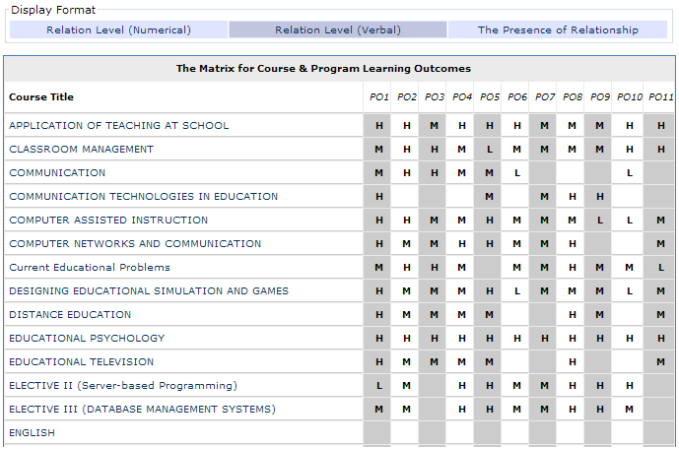


Display Format: Relation Level (Numerical) | Relation Level (Verbal) | The Presence of Relationship

The Matrix for Course & Program Learning Outcomes

Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
APPLICATION OF TEACHING AT SCHOOL	5	4	3	5	5	5	3	3	3	5	5
CLASSROOM MANAGEMENT	3	5	5	3	1	2	3	2	3	4	4
COMMUNICATION	2	4	5	2	2	1	0	0	0	1	0
COMMUNICATION TECHNOLOGIES IN EDUCATION	5	0	0	0	2	0	3	5	4	0	0
COMPUTER ASSISTED INSTRUCTION	5	4	3	3	5	2	3	2	1	1	2
COMPUTER NETWORKS AND COMMUNICATION	4	3	2	4	5	3	2	5	0	0	3
Current Educational Problems	2	4	5	2	0	3	3	4	3	3	1
DESIGNING EDUCATIONAL SIMULATION AND GAMES	4	3	3	2	4	1	3	2	2	1	2
DISTANCE EDUCATION	4	3	3	3	2	0	0	4	3	0	3
EDUCATIONAL PSYCHOLOGY	4	4	5	5	5	5	4	5	5	5	4
EDUCATIONAL TELEVISION	4	2	3	2	3	0	0	5	0	0	3
ELECTIVE II (Server-based Programming)	1	2	0	5	5	3	3	5	5	4	0
ELECTIVE III (DATABASE MANAGEMENT SYSTEMS)	2	2	0	4	5	2	2	5	5	2	0
ENGLISH	0	0	0	0	0	0	0	0	0	0	0

Figure 16. Course & Program Learning Outcomes Relation Level (Numerical) Display Format



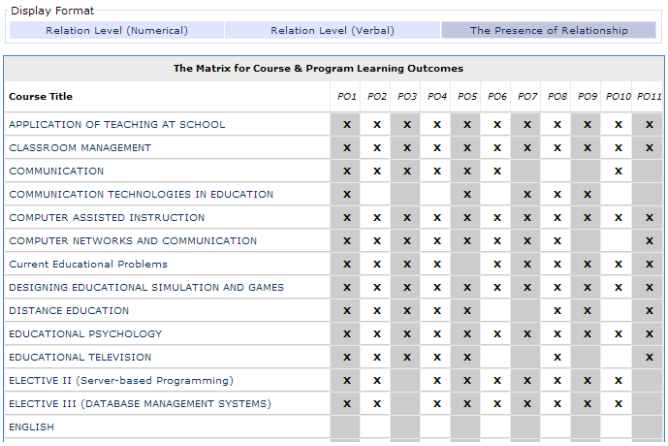
Display Format

Relation Level (Numerical) | Relation Level (Verbal) | The Presence of Relationship

The Matrix for Course & Program Learning Outcomes

Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
APPLICATION OF TEACHING AT SCHOOL	H	H	M	H	H	H	M	M	M	H	H
CLASSROOM MANAGEMENT	M	H	H	M	L	M	M	M	M	H	H
COMMUNICATION	M	H	H	M	M	L				L	
COMMUNICATION TECHNOLOGIES IN EDUCATION	H				M		M	H	H		
COMPUTER ASSISTED INSTRUCTION	H	H	M	M	H	M	M	M	L	L	M
COMPUTER NETWORKS AND COMMUNICATION	H	M	M	H	H	M	M	H			M
Current Educational Problems	M	H	H	M		M	M	H	M	M	L
DESIGNING EDUCATIONAL SIMULATION AND GAMES	H	M	M	M	H	L	M	M	M	L	M
DISTANCE EDUCATION	H	M	M	M	M			H	M		M
EDUCATIONAL PSYCHOLOGY	H	H	H	H	H	H	H	H	H	H	H
EDUCATIONAL TELEVISION	H	M	M	M	M			H			M
ELECTIVE II (Server-based Programming)	L	M		H	H	M	M	H	H	H	
ELECTIVE III (DATABASE MANAGEMENT SYSTEMS)	M	M		H	H	M	M	H	H	M	
ENGLISH											

Figure 17. Course & Program Learning Outcomes Relation Level (Verbal) Display Format



Display Format

Relation Level (Numerical) | Relation Level (Verbal) | The Presence of Relationship

The Matrix for Course & Program Learning Outcomes

Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
APPLICATION OF TEACHING AT SCHOOL	x	x	x	x	x	x	x	x	x	x	x
CLASSROOM MANAGEMENT	x	x	x	x	x	x	x	x	x	x	x
COMMUNICATION	x	x	x	x	x	x				x	
COMMUNICATION TECHNOLOGIES IN EDUCATION	x				x		x	x	x		
COMPUTER ASSISTED INSTRUCTION	x	x	x	x	x	x	x	x	x	x	x
COMPUTER NETWORKS AND COMMUNICATION	x	x	x	x	x	x	x	x			x
Current Educational Problems	x	x	x	x		x	x	x	x	x	x
DESIGNING EDUCATIONAL SIMULATION AND GAMES	x	x	x	x	x	x	x	x	x	x	x
DISTANCE EDUCATION	x	x	x	x	x			x	x		x
EDUCATIONAL PSYCHOLOGY	x	x	x	x	x	x	x	x	x	x	x
EDUCATIONAL TELEVISION	x	x	x	x	x			x			x
ELECTIVE II (Server-based Programming)	x	x		x	x	x	x	x	x	x	
ELECTIVE III (DATABASE MANAGEMENT SYSTEMS)	x	x		x	x	x	x	x	x	x	
ENGLISH											

Figure 18. Course & Program Learning Outcomes The Presence of Relationship Display Format

Course Categories

Course categories are varied as four parts: Supplementary Courses, Basic Occupational Courses, Expertise/Field Courses, Courses on Communication and Management Skills.

Course Categories	ECTS
Supplementary Courses	
Current Educational Problems	4
ENGLISH	4
ERGONOMY AND HEALTH IN INFORMATICS	4
HISTORY OF TURKISH EDUCATION	4
History of Technology and Science	4
Philosophy of Education	4
PUBLISHING DESIGN	4
RESEARCH METHODS	5
SOCIAL SERVICE APPLICATIONS	4
STATISTIC WITH COMPUTER	6
Total	**43**
Basic Occupational Courses	
APPLICATION OF TEACHING AT SCHOOL	14
CLASSROOM MANAGEMENT	5
GUIDANCE	5
INTRODUCTION TO EDUCATION SCIENCE	5

Figure 19. Course Categories

Level of Qualification

This is a first cycle degree program in the science of Computer and Instruction Technologies Education (240 ECTS).
You will be awarded, on successful completion of the programme and gain competencies, a degree of Bachelor in Computer and Instruction Technologies Education.

Admission Requirements

Students must comply with the legal and academic requirements to access the studies in The Sakarya University according to the process established by the ÖSYM (Higher Education Council Student Selection and Placement Centre) regulations. Students who have started studies in other universities within or outside of the country may apply for their recognition. The recognition record is unique for each student and therefore the procedure is carried out accordingly before the start of each academic year. More information about general admission requirements can be found in the catalogue of Information on the Institution.

Under an established exchanges program or one approved by the University, exchange students from abroad may be accepted for studies on the courses taught in English. Or, if they are confident in Turkish, they may then enrol any courses, running in Turkish, shown on the ?Course Structure? diagram.

Occupational Profiles

Upon a successful completion of the programme, student may continue with master and doctoral studies in the same or similar scientific areas, which may accept students from the science of Computer and Instruction Technologies Education.

Graduation Requirements

There is no final examination or examination period at the end of an academic year, or at the end of the study programme. There is, however, a final examination and examination periods, i.e., normally takes two weeks and starts immediately after at the end of each semester. Student is expected to have a successful completion of internship (60 working days) in industry before graduation. Internship is not credited in the programme though it is prerequisite for the graduation. However, the competences gained and workload needed with internship are ensured with the relevant courses` content, practice and worklaod in the programme. In addition to that student is required to complete a degree project and final year dissertation, (taken normally in 7th or 8th semester), which follows an oral presentation.

Assessment and Grading

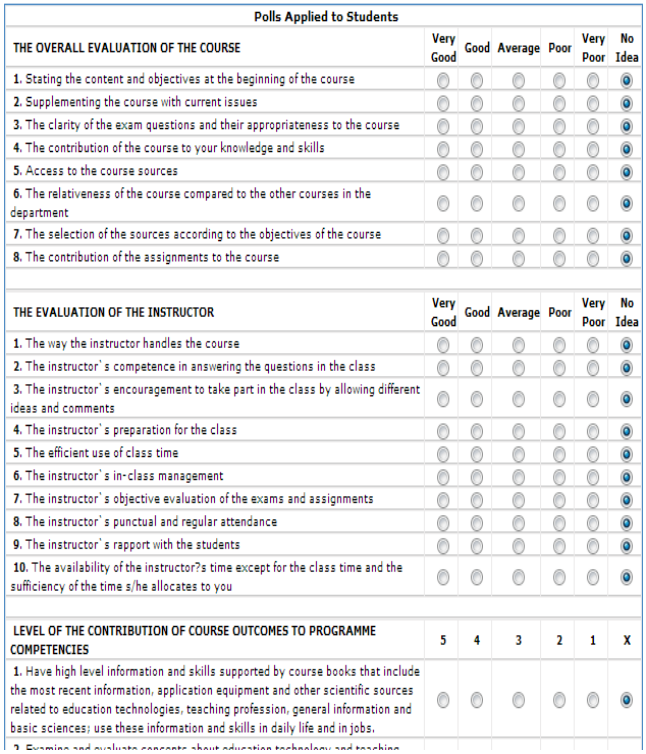
Assessment and grading are specified in each course. When see the Course Structure for details, they are seen.

Prog. Director & ECTS Coord.

In this section programme director’s and ECTS & Erasmus coordinator’s information (mail address, phone number and fax number) are accessed.

Polls Applied to Students

Polls about “The Overall Evaluation of the Course”, “The Evaluation of the Instructor”, “Level of the Contribution Of Course Outcomes to Programme Competencies”, “Workload Determination – ECTS” applied to students are seen from this section.



Polls Applied to Students						
THE OVERALL EVALUATION OF THE COURSE	Very Good	Good	Average	Poor	Very Poor	No Idea
1. Stating the content and objectives at the beginning of the course	○	○	○	○	○	◉
2. Supplementing the course with current issues	○	○	○	○	○	◉
3. The clarity of the exam questions and their appropriateness to the course	○	○	○	○	○	◉
4. The contribution of the course to your knowledge and skills	○	○	○	○	○	◉
5. Access to the course sources	○	○	○	○	○	◉
6. The relativeness of the course compared to the other courses in the department	○	○	○	○	○	◉
7. The selection of the sources according to the objectives of the course	○	○	○	○	○	◉
8. The contribution of the assignments to the course	○	○	○	○	○	◉
THE EVALUATION OF THE INSTRUCTOR	Very Good	Good	Average	Poor	Very Poor	No Idea
1. The way the instructor handles the course	○	○	○	○	○	◉
2. The instructor`s competence in answering the questions in the class	○	○	○	○	○	◉
3. The instructor`s encouragement to take part in the class by allowing different ideas and comments	○	○	○	○	○	◉
4. The instructor`s preparation for the class	○	○	○	○	○	◉
5. The efficient use of class time	○	○	○	○	○	◉
6. The instructor`s in-class management	○	○	○	○	○	◉
7. The instructor`s objective evaluation of the exams and assignments	○	○	○	○	○	◉
8. The instructor`s punctual and regular attendance	○	○	○	○	○	◉
9. The instructor`s rapport with the students	○	○	○	○	○	◉
10. The availability of the instructor?s time except for the class time and the sufficiency of the time s/he allocates to you	○	○	○	○	○	◉
LEVEL OF THE CONTRIBUTION OF COURSE OUTCOMES TO PROGRAMME COMPETENCIES	5	4	3	2	1	X
1. Have high level information and skills supported by course books that include the most recent information, application equipment and other scientific sources related to education technologies, teaching profession, general information and basic sciences; use these information and skills in daily life and in jobs.	○	○	○	○	○	◉

Figure 20. Polls Applied to Students

Strategic Management Information System - SYBS

At Sakarya University, in order to provide the spread and participation of the Strategic Management activities to units, in 2009 Strategic Management Information System has been developed. Strategic Management Information System consists 10 main themes(Strategies, Objectives, Sub-Objectives and Performance Indicators, Activity-Projects) in accordance with the model of YÖDEK. Performance of the units and the university is monitored by Red Area Charts produced by this system. By units, performances are evaluated with the performance reports to the Senate at the end of the year.

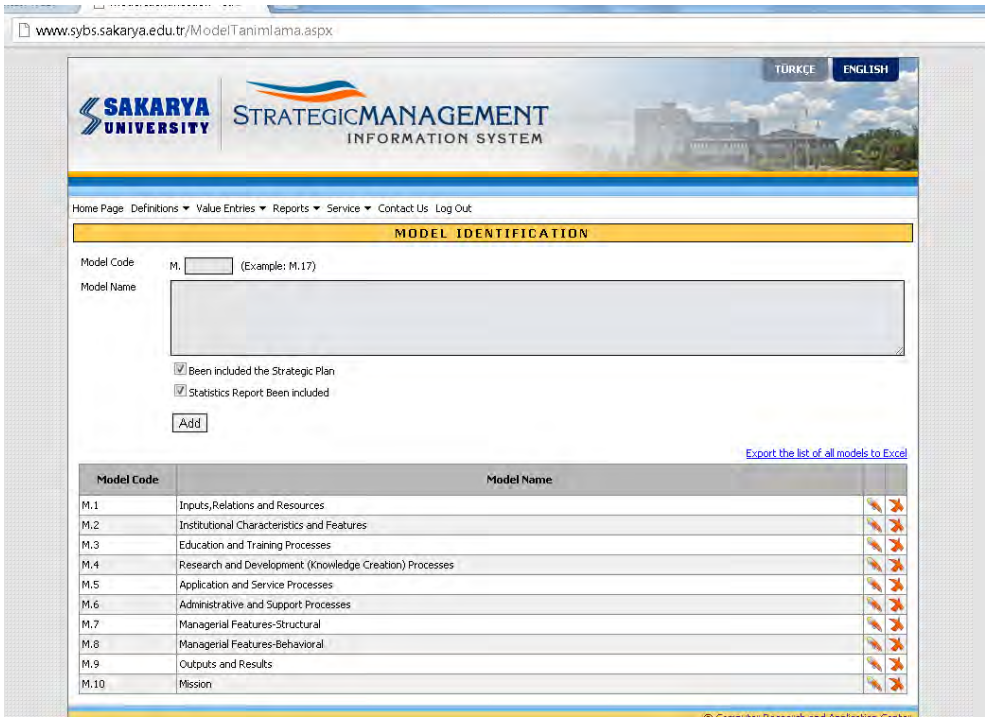


Figure 21. Sakarya University Strategic Management Information System.

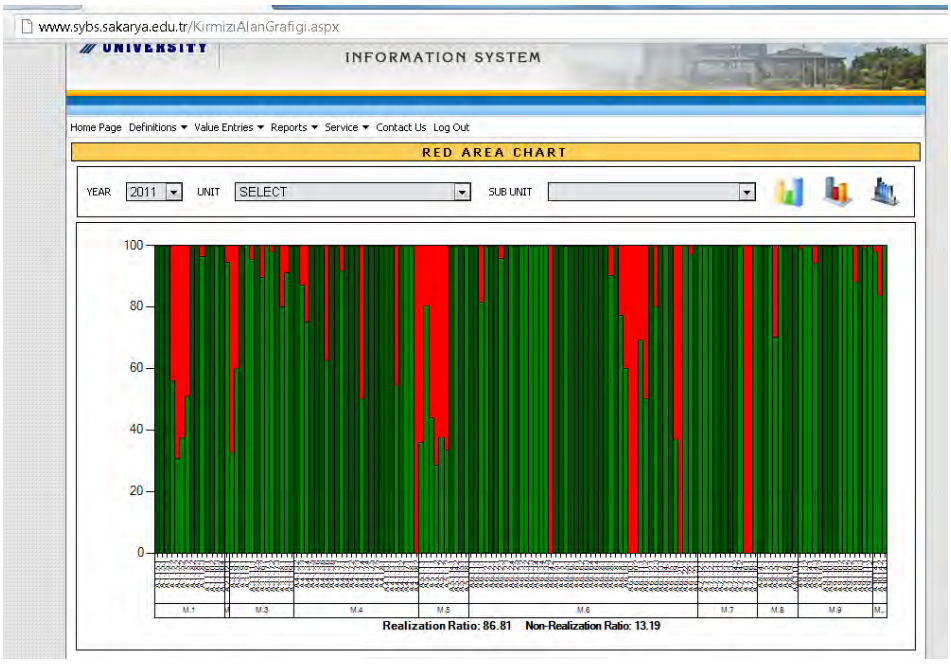


Figure 22. Red Area Chart.

Campus Automation Web Information System - CAWIS

Campus Automation Web Information System (CAWIS) incorporates nine different systems. These have various tasks and contain different processes for several performance.

- **WebGate** - [http://www.gate.sakarya.edu.tr]
- **WebMail** - [http://www.mail.sakarya.edu.tr]
- **WebObis** - [http://www.obis.sakarya.edu.tr]
- **WebAbis** - [http://www.abis.sakarya.edu.tr]
- **WebPbis** - [http://www.pbis.sakarya.edu.tr]
- **WebMenü** - [http://www.menu.sakarya.edu.tr]
- **WebRehber** - [http://www.rehber.sakarya.edu.tr]
- **WebForm** - [http://www.form.sakarya.edu.tr]
- **WebAnket - [** http://www.anket.sakarya.edu.tr]

WebGate - [http://www.gate.sakarya.edu.tr]
WebGate is Campus Automation Web Information System (CAWIS)'s gate and interface to user processes.

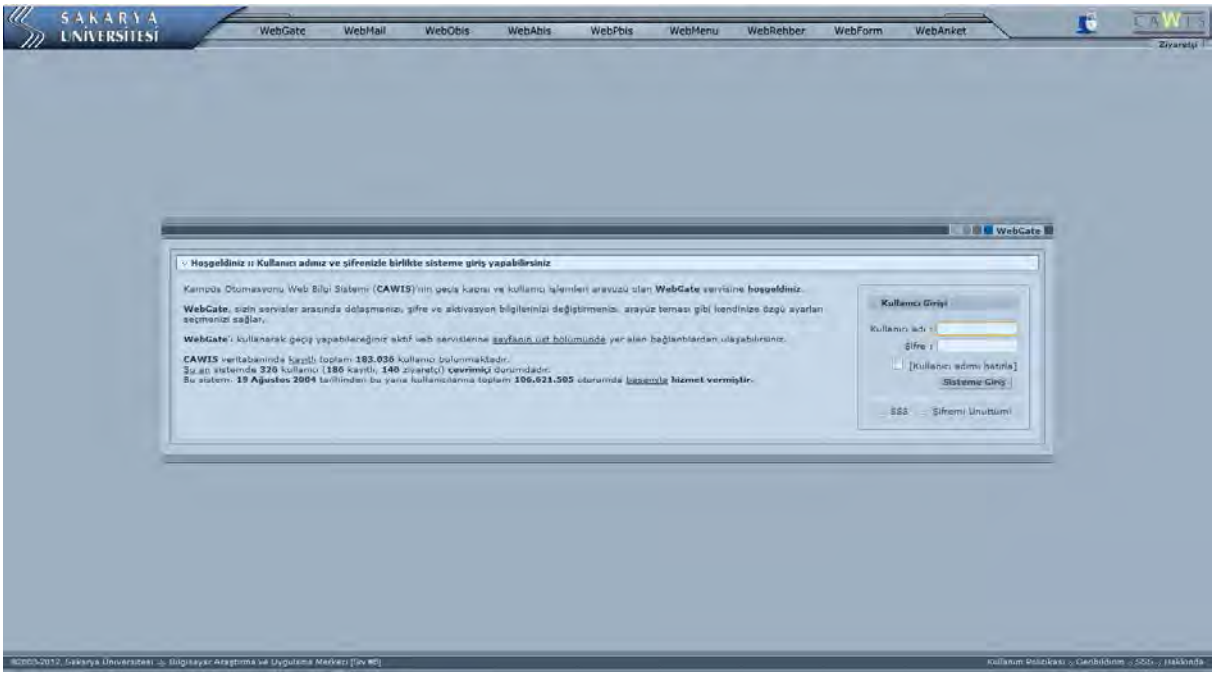


Figure 23. WebGate

WebMail - [http://www.mail.sakarya.edu.tr]
WebMail is CAWIS e-mail interface.

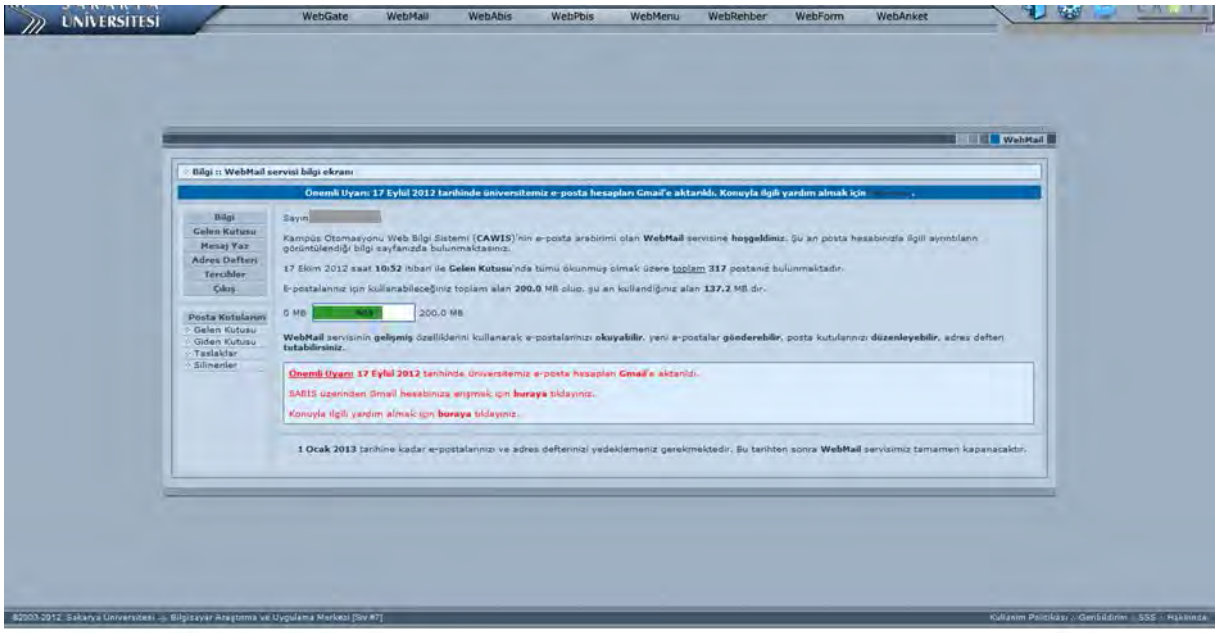


Figure 24. WebMail Information Page

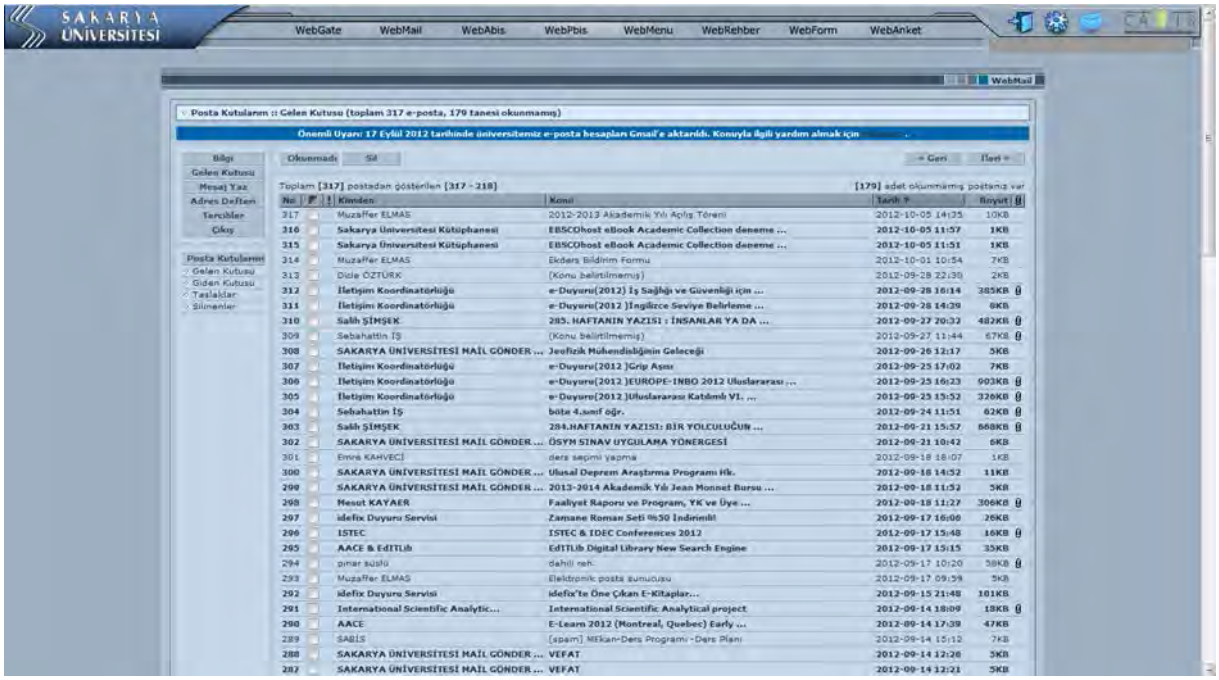


Figure 25. WebMail Inbox

On September 2012, webmail address was changed because Sakarya University made a deal with Google Mail-Gmail. Now academicians and staff access their mail from http://www.posta.sakarya.edu.tr address or SABİS page.

Figure 26. Mail Service User Login

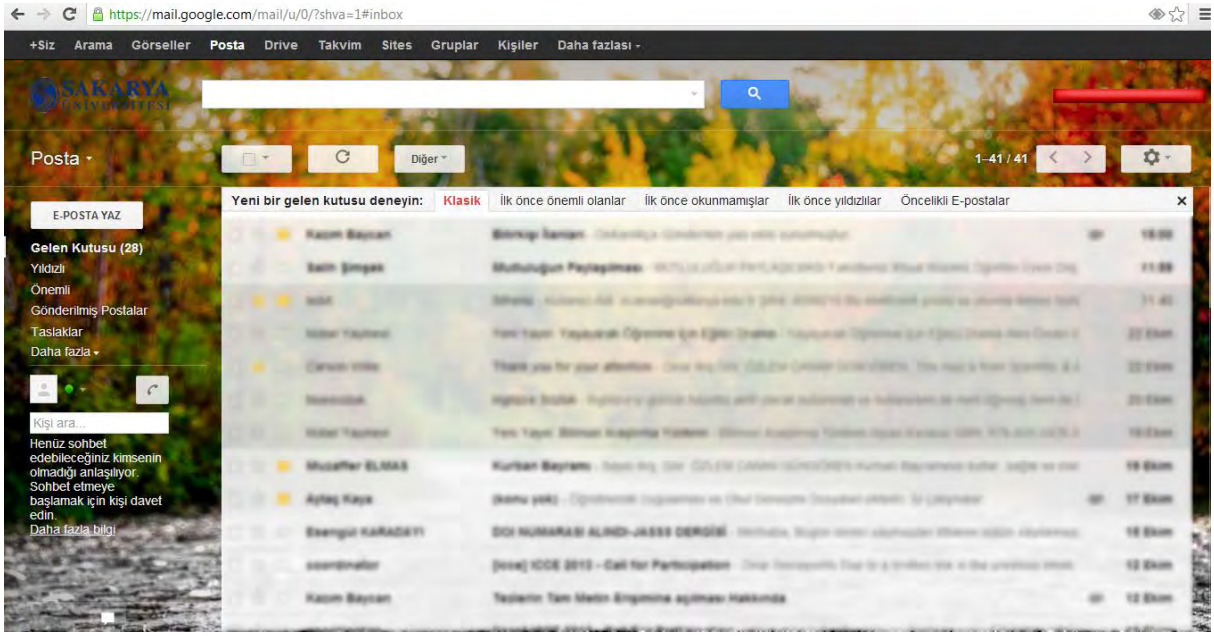


Figure 27. Mail Service Inbox

WebObis - [http://www.obis.sakarya.edu.tr]
WebObis is Student Information System and processes of course selection, viewing scores and transcript are done in this system.

Figure 28. WebObis Information Page

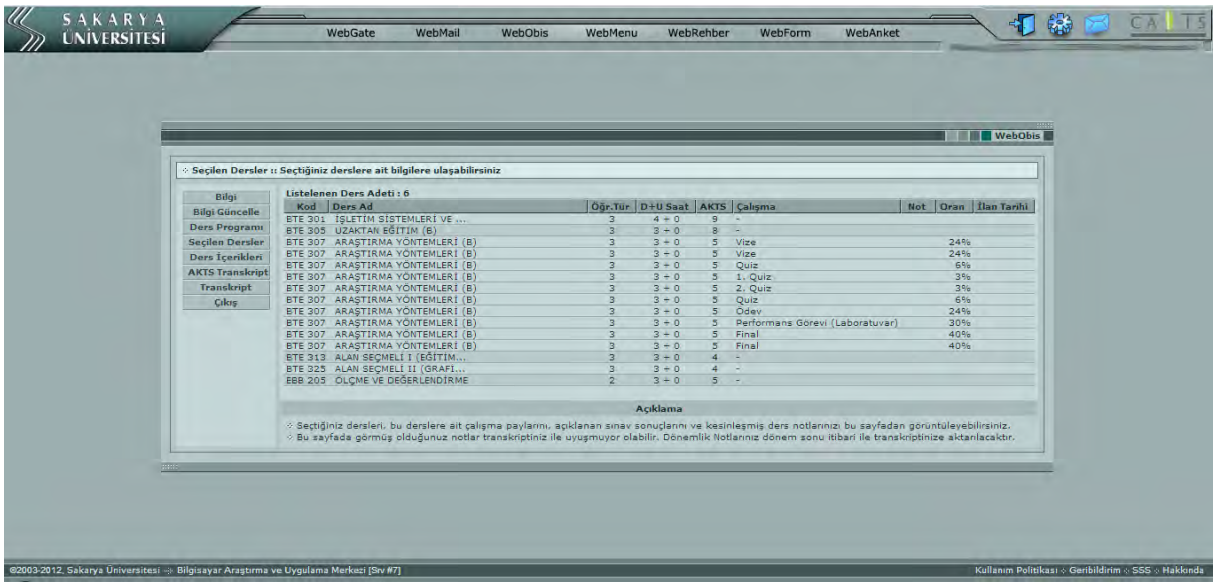


Figure 29. WebObis Course List Page

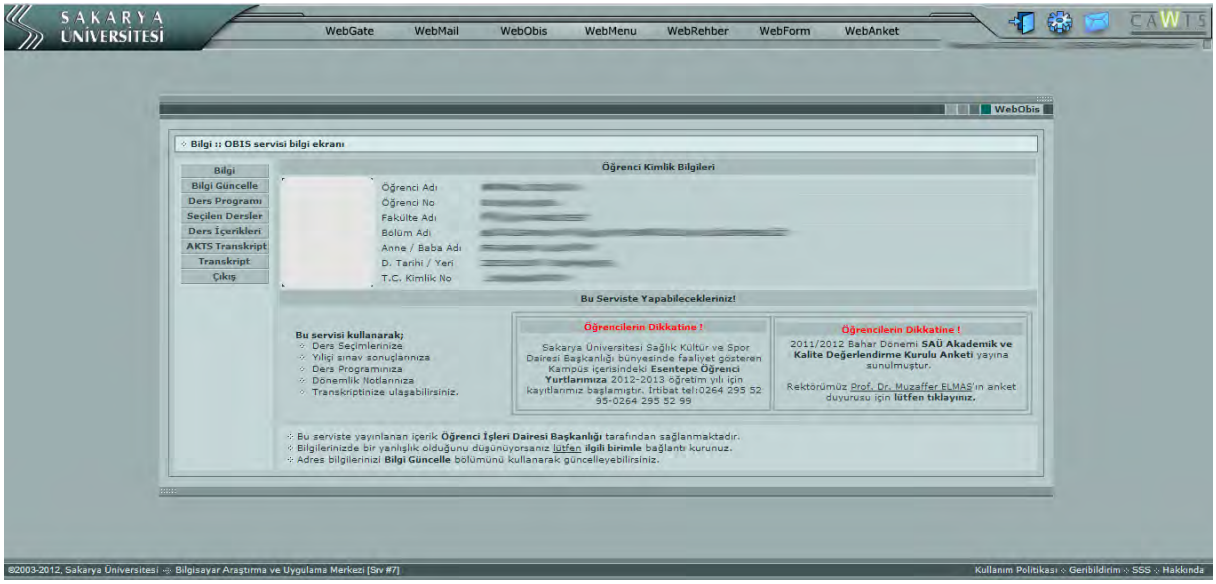


Figure 30. WebObis Student Information Page

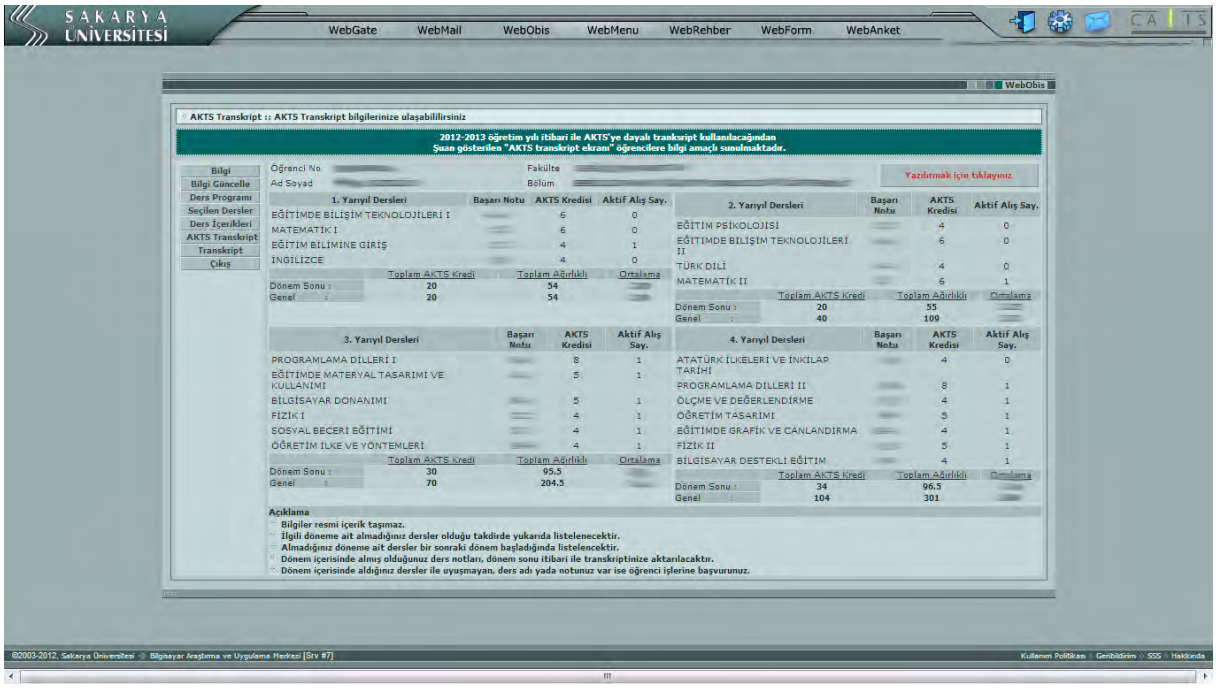


Figure 31. WebObis Transcript Page

WebAbis - [http://www.abis.sakarya.edu.tr]
WebAbis is Academic Information System. From there course selection, giving scores, sharing documents and viewing students lists processes are done.

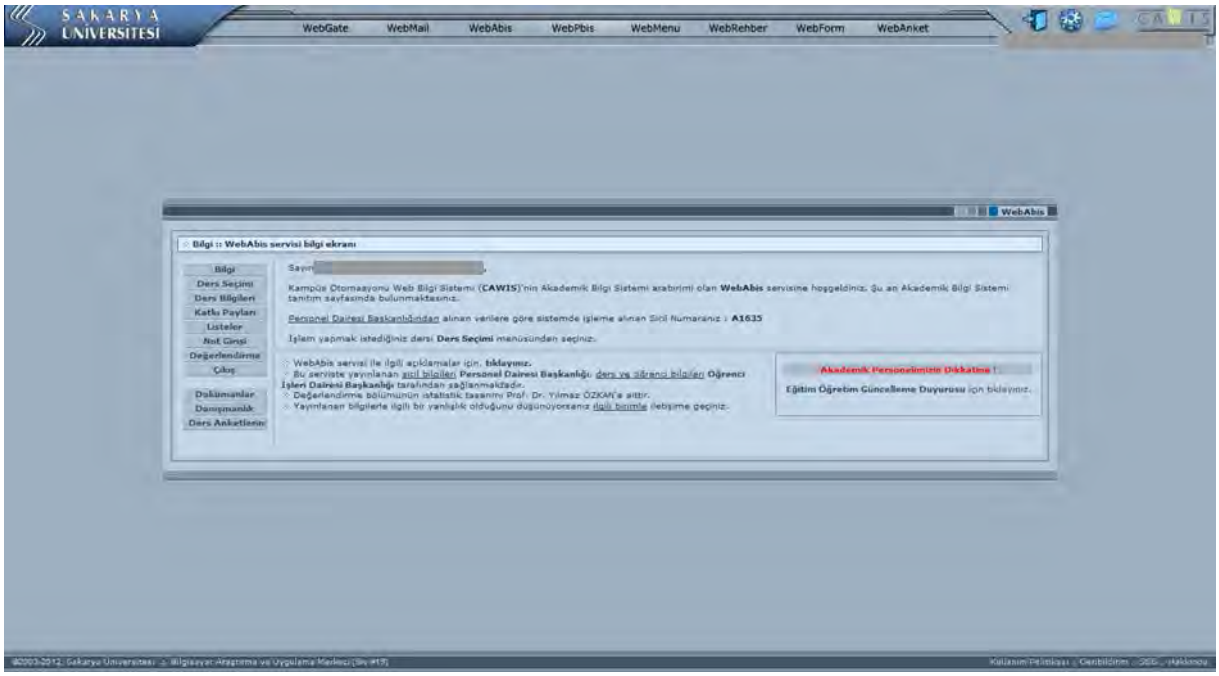


Figure 32. WebAbis Information Page

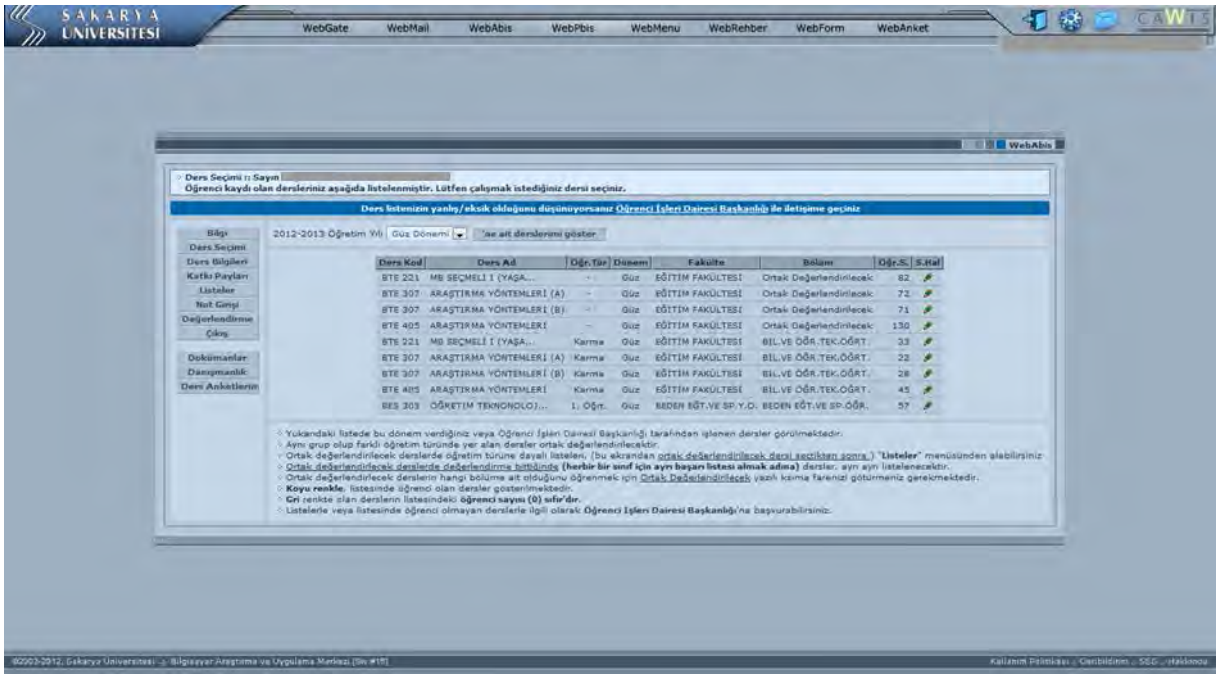


Figure 33. WebAbis Course Selection

Figure 34. WebAbis Scores List

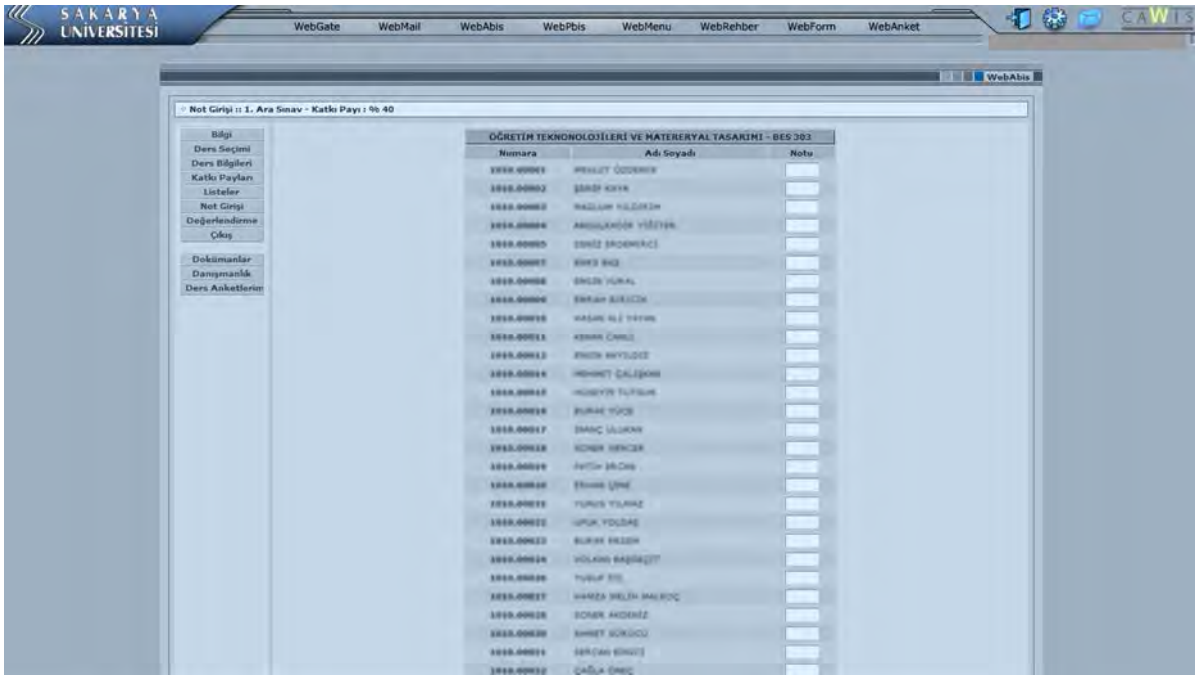


Figure 35. WebAbis Course Scores Entrance

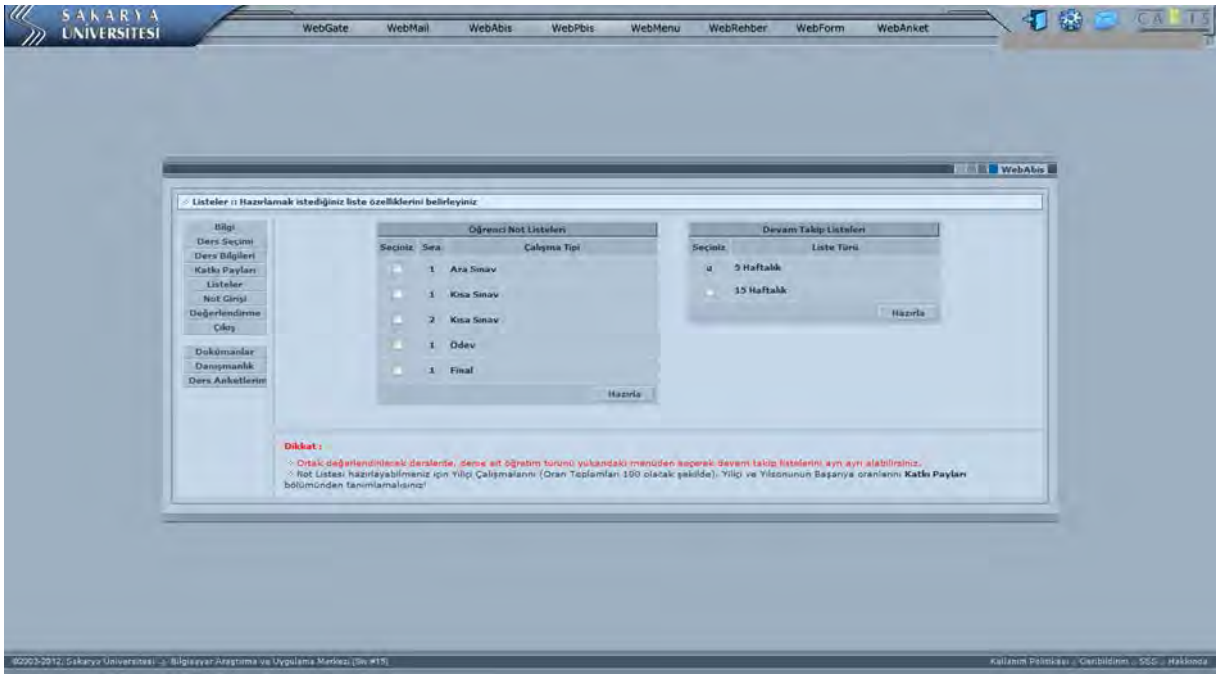


Figure 36. WebAbis Students List Page

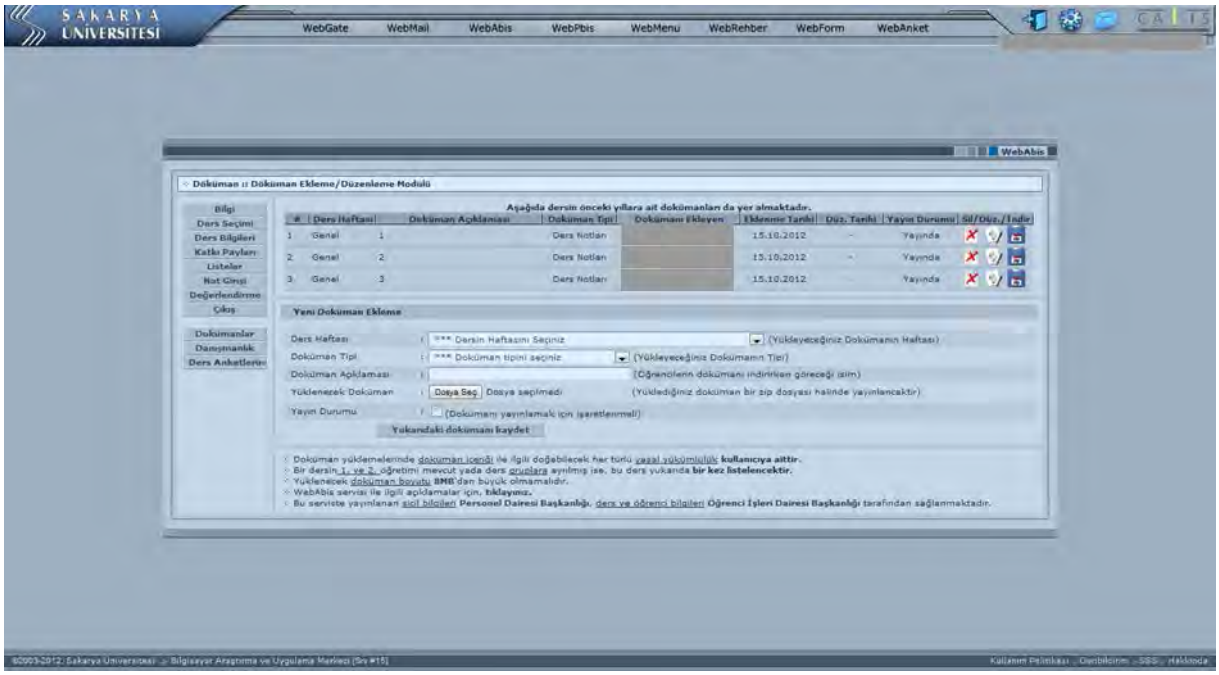


Figure 37. WebAbis Sharing Document

WebPbis - [http://www.pbis.sakarya.edu.tr]
WebPbis is Personal Information System and viewing monthly salary envelope and reports of embezzlement are accessed from this system.

Figure 38. WebPbis Information Page

Figure 39. WebPbis Monthly Salary Envelope

Figure 40. WebPbis Report Of Embezzlement

WebMenü - [http://www.menu.sakarya.edu.tr]
WebMenü is Cafeteria Automation System and this system display monthly meal menu day by day.

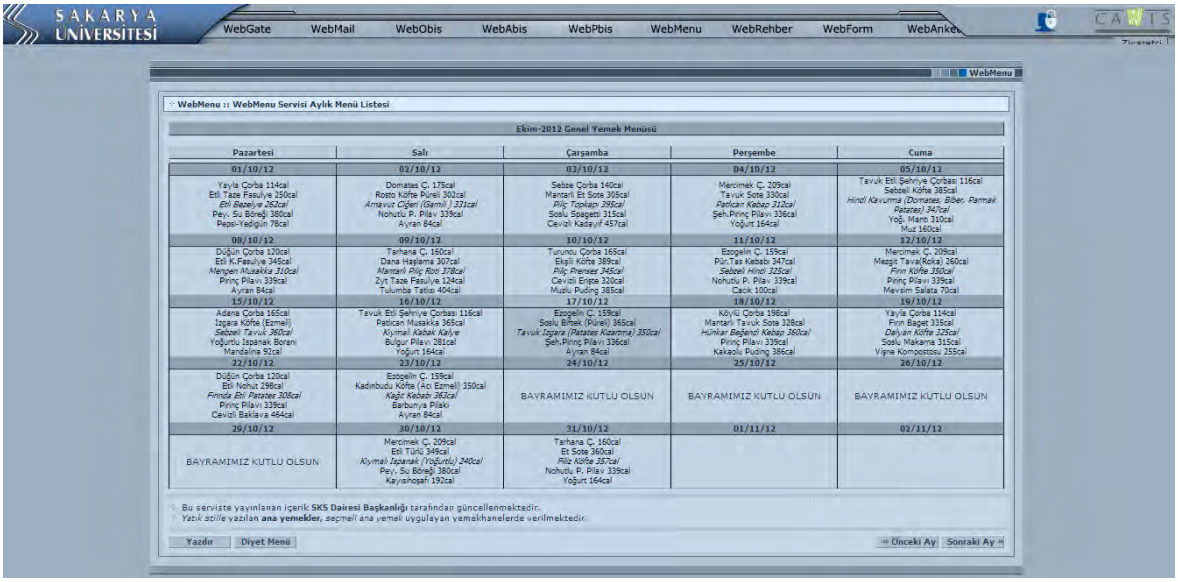


Figure 41. WebMenu Page

WebRehber - [http://www.rehber.sakarya.edu.tr]
WebRehber is Web-Based Phone and E-mail Directory System.

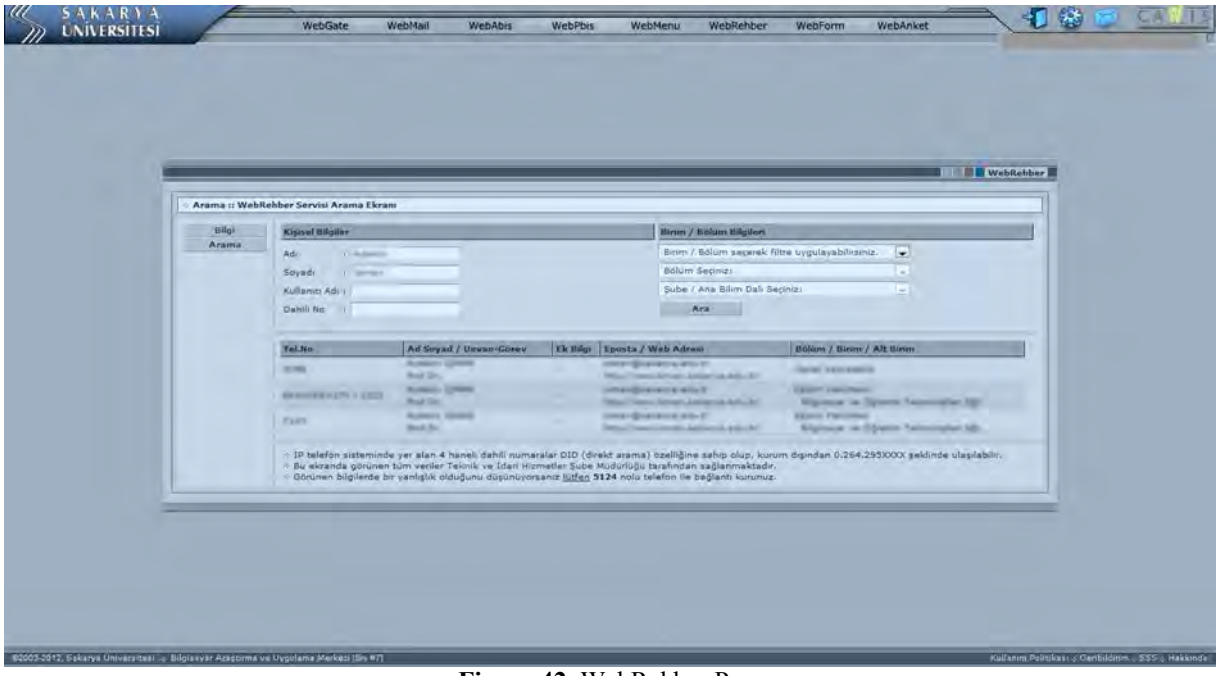


Figure 42. WebRehber Page

WebForm - [http://www.form.sakarya.edu.tr]
WebForm is Web-Based Form Submission System and it is submitted desires, wishes and complaints.

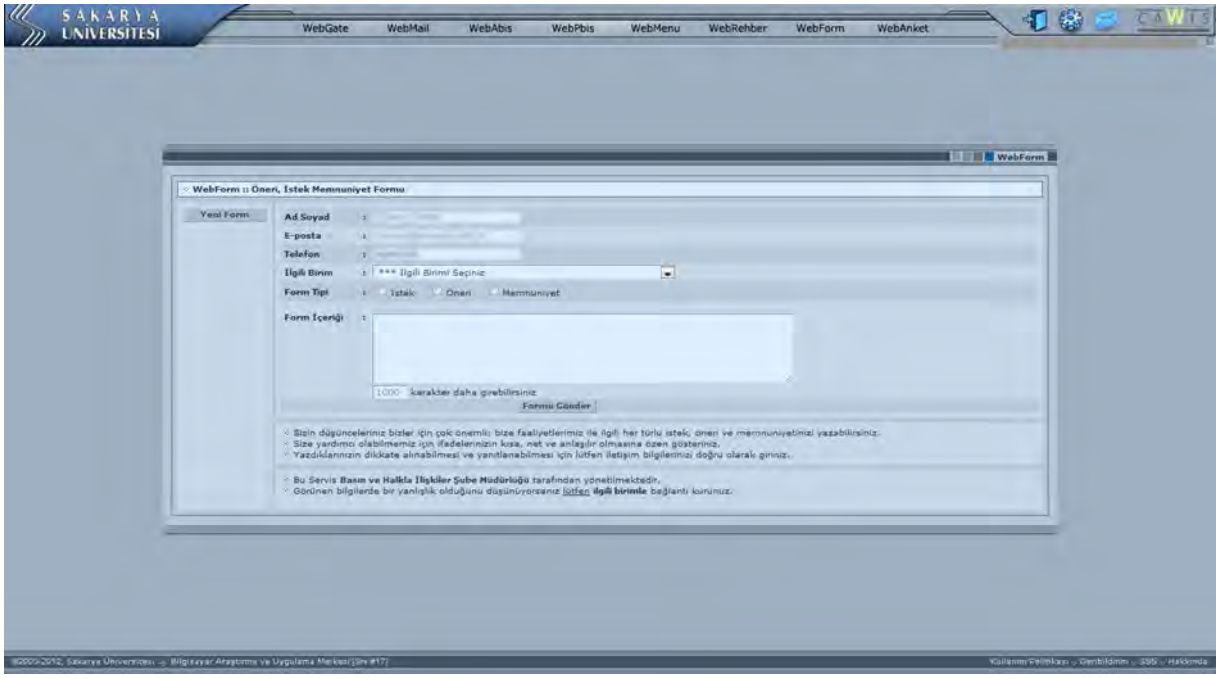


Figure 43. WebForm Page

WebAnket - [http://www.anket.sakarya.edu.tr/]
WebAnket is Web-Based Survey Application System.

Figure 44. WebAnket Page

Conclusion

Technologies have powerful affect in our life. Because of the innovation and development of technology, nowadays everybody use these. The place where technologies are effectively used more is universities. Universities apply these technologies in their activities as online performance systems. Sakarya University is one of the university utilize these technologies with different online systems with their all academicians, students and staff.

In this study Sakarya University's four different online system is introduced for details. These systems are Sakarya University Academic Information System, Educational Information System, Strategic Management Information System, Sakarya University Campus Automation Web Information System. These were founded by Sakarya University and now used effectively. These systems give university more power for managing and increasing the performance.

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The Evaluation of the Implementation Process of Science and Technology Course Curriculum in Elementary Education According to Teachers' Opinions

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Abstract: The aim of the current study is to evaluate the implementation process of the Science and Technology course curriculum based on teachers' opinions in schools with different socioeconomic status (SES). The sample of the current study includes Science and Technology teachers in elementary schools; two of them have high SES, two have middle SES, and two have low SES. These elementary schools were chosen from low- to middle and high SES elementary schools in central district of Sakarya via stratified sampling. The teachers' opinions about the competence of the implementation of the program were obtained by semi- structured interview. The obtained qualitative data was analyzed via content analysis. It was founded that the current program is superior to the old one according to teachers' opinions. However, several factors prevent the implementations of the program, such as insufficient time, insufficiency of materials, individual differences, the population density in some units, class crowding, unprepared students to lessons, placement test (special name is SBS in Turkey), and the process of preparation to exams city- wide, the inappropriateness of the activities to students' level, the unawareness of parents, the difficulty in the access to the sources for students who are not capable of.

Keywords: Science and technology course, curriculum, program evaluation, teachers' opinions.

Introduction

The programs that are used in Teaching- learning process are evaluated to understand the effectiveness of them; if they are not effective, to understand where the problem is derived from. The results of this evaluation serve as a resource to the process of later program development.

With the evaluation of the programs, several factors are supplied, such as making better decisions about the programs, developing better programs, the better use of curriculum (Stake, 1967). Especially, the analysis, and continuous evaluation of "the learning activities that are conducted in classes" elicit the rise of more realistic approaches in the evaluation of the system of education, and the curriculum (Fidan, 1997: 3).

The implementation of the curriculum of any lesson means the development of a teaching and learning process based on the rudiments of that program, and making use of this (Özçelik, 1987:4). The implementation of the curriculum is in the case of linear and straight stages, and occurs radially (Shawer, 2010). In addition, several factors can affect the implementation of the curriculum both positively, and negatively.

In the process of the implementation of the curriculum, important variables that give rise to the actualization of all learning processes take place in all components of the system of education. When the teaching and learning environment is arranged, those variables should be used in a way that fit for purpose because each variable can affect the outcomes of the system. In an education system, which brings students in pre- determined goals of the program, cues, corrections, feedback, and reinforcements should be used in the right place at the right time. Moreover, the equipments, time, and the organization of the classrooms should be arranged in a way that fits to the goals of the learning. Furthermore, the participation of the students to the learning process, the arrangement of the activities that improve the critical, and creative thinking of the students should be supplied with the help of appropriate teaching- learning strategies, methods, and techniques. All of those aforementioned suggestions should intertwine to each other (Sönmez, 2007). Those teaching- learning activities are actualized in stages as preparation (attention getting, motivation, revision), presentation (passing to the lesson, and development), application (individual and group learning activities), and with the implementation of curriculum in stages of application, summation- evaluation, that is in the course of teaching lesson (Akbaşlı, 2011).

Teacher factor comes first among possible factors that affect the implementation of the curriculum because the meaning that teachers give to new curriculum functions as a map in the implementation process of

the curriculum, and this situation indicates the success of the curriculum. Teachers are key factors in the success of new curriculum. The knowledge, beliefs, and understandings of the teachers play a crucial role in understanding new curriculum. Teachers use their daily knowledge and experiences to make sense of new curriculum process, and this affect and shape the meaning that is given by teachers to new curriculum. The understanding and the acceptance of teachers about the new curriculum process have an impact on the implementation of the curriculum (Bantwini, 2010). Spears (1950) stated that to an effective curriculum it should not be forgotten that the curriculum lies in the heart and mind of the teacher (Varış, 1988: 17). Those are teachers, who transform the curriculum from institutional to educational (Shawer, 2010).

In today's world, curriculums are based on constructivist approach, which provide more roles to teachers. It is expected that teachers should be in the center of teaching- learning process, encourage, and guide students. Teaching- learning process should be undergone with activities, experiments, projects, which are conducted with students, because Science and Technology course is learned with doing and experiencing. That is the purpose of the curriculum. Therefore, teachers should apply stuffs that are foreseen in the curriculum in classroom settings.

According to researches, the approach of teachers to the curriculum has significant effects on both their occupational development, students' learning, and in encouraging them to learning (Shawer, 2010).

Depending on aforementioned factors, the purpose of the current study is to determine how teachers implement the curriculum of Science and Technology course, and what they encounter with while implementing it.

Method

Research Method

In the current study, qualitative research method was used.

Population and Sample

The sample of the current study includes Science and Technology teachers in elementary schools; two of them have high SES, two have middle SES, and two have low SES. These elementary schools were chosen from low- to middle and high SES elementary schools in central district of Sakarya via stratified sampling.

Data Collection

In the current study, the interview form that was designed to measure the general views of Science and Technology teachers about the applicability of the foreseen factors in the curriculum of 6th grade Science and Technology course was used. This interview measures not only the opinions of the teachers but also do measure the attitudes and judgments of them toward the curriculum.

Before the preparation of the interview form, the literature was reviewed, and open-ended questions that best describe the sub-problems were written. For the Content validity of the interview, it was consulted to the opinions of the Science and Technology field experts (n=3), teachers (n=5), and program development experts (n=7). The form of the questions was revised based on the feedbacks of experts. Revised version was broached to same experts again. After taking the expert approval, the interview form was filled out by Science and Technology teachers other than research sample (n=3) to test the functionality and the clarity of the questions. Then structured interview was applied to sample.

Interviews were carried out at times that were suitable for the teachers' schedule. In order to prevent data loss, recorder was used during interviews with taking the permission of the teachers, and the interviews lasted approximately 25-35 minutes.

Analysis of Data

Data that was obtained by interview form was analyzed with content analysis. For the content analysis, firstly, data was recorded to a recorder, and then was transformed into a written material. The written materials were examined repeatedly, and data that was appropriate for the purpose of the study were codified. Then categories (themes) that described codified data generally were determined. Those findings were organized as tables. Teachers, participating in interview, were coded as G1, G2, G3, G4, G5, and G6. In the evaluation process of the findings, direct quotations about opinions of teachers were used.

Result and Discussion

Data that was obtained through interviews with teachers was coded in accordance with determined categories, and was presented as tables.

- Teachers' Opinions About Preparation Of The Learning Environment That Fits the Gains

  Themes that are effective in the preparation of the learning environment, which fits to the gains, according to teachers' opinions, and the codes are represented in Table 1.

Table 1. Teachers' opinions about preparation of the learning environment that fits the gains

Teacher	School SES	Themes (categories)		
		Preparation Situation	**Positive Effect**	**Negative Effect**
G1	High	I try to prepare a suitable learning environment with respect to the potential of the school	Utilization of the guidance book	Unprepared students come to classes Insufficiency of materials Insufficiency in the technological condition of the school
G2	High	I prepare learning environment that fits most of the gains	Utilization of the guidance book Utilization of the computer and the projector	Insufficiency of materials Students' levels are low
G3	Middle	I try to prepare a suitable learning environment with respect to the potential of the school	-	Unprepared students come to classes
G4	Low	I cannot prepare a learning environment that fits to every gain	Utilization of the guidance book	Insufficiency of materials Crowded classes Insufficiency in time Density in the program
G5	High	I prepare learning environment that fits most of the gains	Utilization of the guidance book Having a laboratory Utilization of the computer and the projector	Crowded classes Insufficiency in time Density in the program The early application of the SBS
G6	Middle	I cannot prepare a learning environment that fits to every gain	-	Unprepared students come to classes Insufficiency in materials

As represented in Table 1, opinions of teachers were gathered into three categories, namely "Preparation Situation," "Positive Effect," and "Negative Effect." When teachers' situations about preparing a learning environment that fits to gains were investigated, it was founded that two teachers prepare learning environment that fits to most of the gains, two of them try to prepare learning environment according to the potential of the school, and two of them cannot prepare learning environment that fits to every gains. Direct quotations that were gotten from teachers' opinions are as follows:

"It differs according to the situation of the school… gains are useful but it is not possible to apply all of them. (G1)

"I have the edge on this situation because there is a laboratory, computer, and projector in the school. I can provide visuality to students by using them. I think that I cannot provide all the gains but I can do most of them..." (G5)

When teachers' opinions about the negative effect of preparing a learning environment were investigated, it was founded that four of them mentioned the insufficiency of the materials; three of them mentioned students' unpreparedness; two of them mentioned the crowdedness of the classes, insufficiency in time, density in the program; one of them mentioned the insufficiency in the technological condition of the school; one of them mentioned the low level of students' capacity, and one of them mentioned the early application of SBS exam in Turkey. Direct quotations that were gotten from teachers' opinions are as follows:

"... because of the crowdedness of the classes, insufficiency in the materials of laboratory, we cannot do experiments, so we cannot give every gain to students. In addition to these, there is a problem in time management; the subjects of 7th grade cannot be finished. It is important to learn Science and Technology course with seeing, and doing, but we cannot fulfill it..." (G4)

- Teachers' Opinions About The Improvement In Students' Learning Desires

What teachers do at the beginning of the classes to increase the desires of students' in terms of learning in the process of teaching- learning was shown in Table 2.

Table 2. Teachers' Opinions About The Improvement In Students' Learning Desires

Teachers	**School SES**	**Themes (categories)**	
		Example	**Question**
G1	Low	I give examples from daily life I give examples from news in TV programs and news in the media	-
G2	High	I give examples from daily life I use pictures at the beginning of the units	I test the knowledge of students that they learned at 4th and 5th grades
G3	Middle	I give examples from daily life	I test the knowledge of students that they learned at 4th and 5th grades
G4	Low	I give examples from daily life	I begin classes with asking questions
G5	High	I give examples from daily life I begin classes with a suitable object to the subject	I test the knowledge of students that they learned at 4th and 5th grades
G6	Middle	I give examples from daily life I give examples from news in TV programs and news in the media	I begin classes with asking questions

As shown in Table 2, the opinions of teachers were gathered into two categories, namely "example," and "question." When opinions of teachers who want to choose giving examples to increase students' desires were investigated, all of the teachers stated that they give examples from daily life. Direct quotations that were gotten from teachers' opinions are as follows:

"By giving examples from daily life, I try to draw students' attention to the subject…" (G4)

"It could be an object that draws attention to the subject… I try to capture their attention by giving examples from daily life because the lesson is about the real life…" (G5)

When opinions of teachers who want to chose questions to increase students' desires were investigated, three of the teachers begin classes with testing students' knowledge that they learned at 4th and 5th grades, two of them begin classes with asking questions to capture attention. Direct quotations that were gotten from teachers' opinions are as follows:

"... I begin classes with question and answer section to draw attention of the students… "(G4)

"... The method that I use mostly is asking questions about daily life… for example, in order to explain the movement of the Earth and the Moon, I ask that "did you see the Moon last night?","how it looked like?" Thus, I can draw their attention… (G6)

- Teachers' Opinions About The Implementation Of The Activities That Fit To The Gains

Teachers' opinions about the implementation of the activities that fit to the gains in the teaching-learning process was shown in Table 3.

Table 3. Teachers' opinions about the implementation of the activities that fit to the gains

Teacher	School SES	Themes (categories)	
		Planning, presenting, and creating activities	**Application time, place, and opportunities**
G1	Low	-	I cannot apply because there is no laboratory and materials
G2	High	I try to apply two out of three activities in the guidance book I want students to bring materials for some activities I get students to watch activities that we cannot do in class on the internet	-
G3	Middle	We cannot apply all the activities I give homework to students about activities that we cannot do in class. I get students to watch activities that we cannot do in class on the internet	I have trouble in terms of timing The capacity and the readiness of the students affect the application of the activities
G4	Low	I sometimes do activities	I have trouble in terms of timing The crowdedness of the class prevents the application of the activities I do not get students to do activities because it is dangerous
G5	High	I try to apply two out of three activities in the guidance book I want students to bring materials for some activities I give homework to students about activities that we cannot do in class If I find different activities, I try to do them also. I do some activities myself and students watch me.	I have trouble in terms of timing The crowdedness of the class prevents the application of the activities
G6	Middle	I want students to bring materials for some activities	I cannot apply because there is no laboratory and materials

As shown in Table 3, teachers' opinions were gathered into two categories, namely "Planning, Presenting, And Creating the Activities," and "Application Time, Place, and Opportunities."

When teachers' opinions about the planning, presenting, and creating the activities category was investigated, it was founded that three of them reflected that they want students to bring materials, two of them stated that they try to do two out of three activities in the guidance book, two of them reflected that they get students to watch the activities that they cannot do in class, on the internet, two of them reflected that they give homework to students about activities that they cannot do in class, one of them pointed out that he does activities sometimes, and one of them declared that he tries to do different activities, and he does some activities himself and gets students to watch him. Direct quotations that were gotten from teachers' opinions are as follows:

"I cannot do all activities. I give homework to students about activities that we cannot do in class or I get students to watch them on Vitamin program on internet…" (G3)

"… I want students to bring some materials from their home and we try to do activities with them as much as possible …" (G6)

When teachers' opinions about the application time, place, and opportunities of the activities category was investigated, it was founded that three of them stated that they have troubles in terms of timing, two of them stated that the crowdedness of the classes prevent the application of the activities, two of them stated that they cannot do activities because there is no laboratory and materials, one of them stated that the capacity and the readiness of the students affect the application of the activities, and one of them stated that she does not get students to do activities because it is dangerous. Direct quotations that were gotten from teachers' opinions are as follows:

"The activities cannot be done because of the school's conditions, like lack of laboratory and insufficiency in materials." (G1)

"If we try to do activities, we have trouble in timing. All activities that are mentioned in the program can surpass students' capacity. Students' readiness affects the application of the activities." (G3)

Researches show that teachers adopt the activities largely, and they try to do them (Doğan, 2009), but the high number of activities (Sert, 2008) and the lack of time make them have trouble in the application process (Wood, 2001; Sert, 2008; Tekbıyık ve Akdeniz, 2008). Moreover, only a few number of teachers do activities about subject in class (Akdeniz, Yiğit ve Kurt, 2002), and the program is not fulfilled as foreseen and enough (Gözütok, Akgün ve Karacaoğlu, 2005; Kurtuluş ve Çavdar, 2011). Besides, teachers have trouble in using local opportunities, organizing excursions, and doing research about immediate surroundings in the application of activities (EARGED, 2006). Similarly, teachers stated that they can do one experiment in a week because of the conditions of classes, they give activities as homework (Kesercioğlu, Türkoğuz, Kılınç ve Toprak, 2006), and the lack of experiments in the application of the curriculum (Wood, 2001).

- Teachers' Opinions About The Methods And Techniques That They Use In The Learning Process

Teachers' opinions about which methods and techniques they use mostly in the teaching- learning process were shown in Table 4.

Table 4. Teachers' Opinions About The Methods And Techniques That They Use In The Learning Process

Teachers	**School SES**	**Themes (categories)**	
		Teacher- centered	**Student- centered**
G1	Low	Question- answer teaching method	Brainstorming
G2	High	Formal lecture method Question- answer teaching method Demonstration	Discussion Brainstorming Six thinking hats Drama
G3	Middle	Question- answer teaching method Demonstration	Discussion Group work
G4	Low	Question- answer teaching method	Discussion Brainstorming
G5	High	Formal lectures Question- answer teaching method Demonstration	Observation
G6	Middle	Question- answer teaching method	Drama

As demonstrated in Table 4, teachers' opinions were gathered into two categories, namely "Teacher-centered," and "Student- centered."

When the opinions of teachers that use the teacher- centered approach were investigated, it was founded that all of them use mostly question- answer method, three of them use demonstration method, and two of them use formal lectures. Direct quotations that were gotten from teachers' opinions are as follows:

"I use firstly the formal lectures, I use mostly the question- answer, I give examples from daily life, and I use visual materials…" (G2)

"The method that I use mostly is question- answer …" (G6)

When the opinions of teachers that use the student- centered approach were investigated, it was founded that three of them use discussion method, three of them use brainstorming, two of them use drama, one of them uses six thinking hats, one of them uses observation, and one of them uses group work technique. Direct quotations that were gotten from teachers' opinions are as follows:

"… I sometimes use brainstorming and discussion. This change depends on the subject." (G4)

"… I use drama to show the atom models, the movement of the gases, liquids, and solids…" (G6)

Studies indicate that in the teaching process, the applicability of methods and techniques that foreseen in the curriculum in the class settings is not sufficient. Besides, the student- centered method is not common (Bayrak ve Erden, 2007), and it is not possible to use different teaching methods because of the crowdedness of classes (Erdoğan, 2007). Most of the teachers teach according to teacher- centered approach (Akdeniz, Yiğit ve Kurt, 2002; Yıldırım, 2011), and they use mostly the brainstorming, discussion, question- answer, group work, expression, and examples. On the contrary, they occasionally use problem solving, role playing, drama, demonstration, game method (Şahin, Turan ve Apak, 2005). Moreover, they focus on cooperative teaching (Özdemir, 2006), question- answer formal lectures (Özdemir, 2006; Güneş, Şener-Dilek, Hoplan ve Güneş, 2012). On the other hand, they seldom use laboratory, demonstration, experiment, travel- observation, analogy, projects (İzci, Özden ve Tekin, 2006).

- Teachers' Opinions About The Creation Of Democratic Learning Environment

When teachers' opinions about what they do for the creation of democratic learning environment was investigated, G6 teacher that work at a school with middle SES, stated that it is hard to create a democratic learning environment in class. G4 teacher, who work in a school with low SES indicated that the intergroup communication of students is low because of the lack of group works. Direct quotations that were gotten from teachers' opinions are as follows:

"It is difficult to create a democratic learning environment in classes because there are active students as well as passive ones…" (G6)

"… I cannot get students do group work, so that the interaction within students is not well enough…" (G4)

Factors that are important in terms of the creation of democratic learning environment according to teachers' opinions were demonstrated in Table 5.

Table 5. Teachers' opinions about the creation of democratic learning environment

Teachers	School SES	Themes (categories)			
		Encouragement	**Respect**	**Giving opportunity to speak**	**Trust**
G1	Low	-	I give importance to students' respect to each other	I try to give equal opportunity to speak to each student	-
G2	High	-	-	I try to give opportunity to speak to all students	I try to call students by their first name to make them trust themselves
G3	Middle	I encourage students to express their opinions clearly	-	-	-
G4	Low	I try to make students, who are passive and timid, involve in discussion by asking questions	-	-	-
G5	High	I tell students that they can ask questions about everything	I give importance to students' respect to each other	-	-
G6	Middle	-	-	I try to give equal opportunity to speak to each student	-

According to Table 5, teachers' opinions were gathered in four categories, namely "Encouragement," "Respect", "Giving Opportunity to Speak," and "Trust."

When teachers' opinions about the category of encouragement were investigated, it was founded that one of them encourages students to explain their ideas clearly, one of them tells students to ask questions about everything, one of them tries to get passive students participate to lesson with asking questions. Direct quotations that were gotten from teachers' opinions are as follows:

"… I try to encourage students to participate in class. I try to get them participate in class. When they give wrong answers I say "maybe, we think in detail," instead of "it is wrong" to make them explain their ideas without hesitation. Thus, I try to create a democratic learning environment…" (G3)

When teachers' opinions in the category of respect were investigated, it was founded that two of them give importance to make students respect for each other. Direct quotations that were gotten from teachers' opinions are as follows:

"When students share their opinions, I give importance to make others not tease. I try to give awareness to students about this issue…" (G1)

When teachers' opinions about giving opportunity to speak were investigated, it was founded that two of them try to give equal opportunity to every students, one of them tries to give opportunity to speak to every student. Direct quotations that were gotten from teachers' opinions are as follows:

"I give opportunity to speak to every student." (G1)

"... I try to give equal opportunity to speak to students as far as in me lies..." (G6)

When teachers' opinions about the category of trust were investigated, it was founded that G2 teacher that work at a school with high SES uses students' first names to make them believe in themselves.

Gözütok, Akgün and Karacaoğlu (2005) stated that teachers do not give importance to students' opinions, and there is no positive democratic learning environment in classes.

- Teachers' Opinions About Alternative Testing And Measurement Methods

Teachers' opinions about alternative testing and measurement methods in teaching- learning process were demonstrated in Table 6.

Table 6. Teachers' opinions about alternative testing and measurement methods

Teachers	**School SES**	**Themes (categories)**	
		Alternative methods and their drawbacks	**Classic methods**
G1	Low	I do not use alternative testing and measurement methods Scales place a burden because there is too much work related to photocopy	In exams, I prepare multiple choice, short essays, true false, and fill in the blanks questions. In class, I do verbal exam in question and answer format
G2	High	I do not prefer to use alternative testing and measurement methods that foreseen in the curriculum Volunteer students prepare product file I give performance grade (final grade) according to students' participation in classes Extra time is needed to use scales	In exams, I prepare multiple choice, short essays, true- false, matching fill in the blank questions I prefer mostly multiple choice questions because we prepare students to SBS exam
G3	Middle	I do not prefer to use alternative testing and measurement methods that foreseen in the curriculum Volunteer students prepare product file I give performance grade (final grade) according to students' participation in classes Scales place a burden because there is too much work related to photocopy	In exams, I prepare multiple choice, short essays, true- false, matching fill in the blank questions
G4	Low	I give projects to volunteer students I give performance projects to students about subjects that they can do research	In exams, I prepare multiple choice, short essays, true- false, matching fill in the blank questions
G5	High	I do not prefer to use alternative testing and measurement methods that foreseen in the curriculum I give projects to volunteer students Extra time is needed to use scales	In exams, I prepare multiple choice, short essays, true- false, matching fill in the blank questions
G6	Middle	I do not prefer to use alternative testing and measurement methods that foreseen in the curriculum I give projects to volunteer students I give performance grade (final grade) according to students' participation in classes Students determine their project subject Extra time is needed to use scales Scales place a burden because there is too much work related to photocopy	In exams, I prepare multiple choice, short essays, true- false, matching fill in the blank questions

According to Table 6, teachers' opinions were gathered into two categories namely, "Alternative Methods, and Their Drawbacks," and "Classic Methods."

When teachers' opinion about the category of alternative methods and their drawbacks were investigated, it was founded that four of them do not prefer to use alternative testing and measurement methods that foreseen in curriculum, three of them give performance note (final grade) to students according to their participation in class, there of them give projects to volunteer students, three of them stated that extra time is needed to use scales, three of them indicated that scales place a burden because there is too much work related to photocopy, two of them mentioned that volunteer students prepare product file, one of them does not use alternative testing and measurement methods, one of them gives projects and performance home works seldom, one of them stated that students determine their own project subject, one of them gives performance home works that enable students to do research. Direct quotations that were gotten from teachers' opinions are as follows:

"Scales that are foreseen in the guidance book do not allow us to teach a lesson. So I do not use that scales." (G1)

"... I give projects to volunteer students as term paper. They chose their own subject themselves after I determine possible subjects. I give performance homework that enables them to do research…" (G4)

When teachers' opinions about classic methods were investigated, it was founded that all teachers prepare multiple choice, short essays, true- false, matching, fill in the blank questions in exams. One of them does verbal exam in class as question- answer format. One of them prefers multiple-choice questions because we prepare students to SBS. Direct quotations that were gotten from teachers' opinions are as follows:

"I try to prepare exam questions in accordance with curriculum. I use multiple- choice, fill in the blank, short essays questions in exams, but not the scales that are foreseen because there is too much photocopy work there, which brings extra burden. Thus, I evaluate students with my own exams…" (G3)

"...My exam questions are multifarious. Indeed, they include true- false, fill in the blank, multiple-choice question…" (G5)

Researches show that teachers pointed out about the evaluation of the curriculum that evaluation examples foreseen in the curriculum is necessary but they are not sure about the applicability of it (Bayrak ve Erden, 2007), even they do not apply it (Kurtuluş ve Çavdar, 2011). Similarly, they stated that the testing and measurement is not done enough because there is too much evaluation methods (Gündoğar, 2006; Sert, 2008), they are too complicated (Ersoy, 2008; ERAGED, 2006; Selvi, 2006), and they place a burden to teachers (Aydın ve Çakıroğlu, 2010; Özdemir, 2007), and there are some problems related to its implementation (Ayvacı ve Devecioğlu, 2009; Kurtuluş ve Çavdar, 2011; Bantwini, 2010). Moreover, they indicated that they have problems in terms of the implementation of the testing and measurement methods (Ayvacı ve Devecioğlu, 2009), and they consider themselves as inadequate in this issue (Gözütok, Akgün ve Karacaoğlu, 2005). Doğan (2009) founded that teachers who work in schools with high SES are more likely to use testing and measurement methods.

- Teachers' Opinions About The Implementation Of Science And Technology Curriculum

Teachers' opinions about the implementation of the Science and Technology curriculum in teaching-learning process were shown in Table 7.

Table 7. Teachers' opinions about the implementation of the Science and Technology curriculum

Teachers	School SES	Themes (categories)		
		Application situation	**Factors making application easier**	**Factors making application difficult**
G1	Low	I think that I do not apply	-	The potentials of the school is not suitable Parents' unconcernedness and their economical problems are disadvantages
G2	High	I apply	In the application process, I use teacher guidance book	The insufficiency in materials is a problem The preparation to SBS exam affects the application of the program
G3	Middle	I think that I apply in terms of approach	In the application process, I use teacher guidance book	-
G4	Low	I think that I do not apply	-	The crowdedness of the classes affect the application The laboratory is not available The potentials of the school are not enough
G5	High	I think I apply by 80%	The student exercise books make it easier to apply the program	The crowdedness of the classes affect the application The preparation to SBS exam affects the application of the program
G6	Middle	In think that I apply in terms of approach	-	The laboratory is not available The insufficiency in materials is a problem

According to Table 7, teachers' opinions were gathered into three categories, namely "Application Situation," "Factors Making Application Easier," "Factors Making Application Difficult."

When teachers' opinions in the category of application situation were investigated, it was founded that two of them do not think they apply the program, two of them think they apply in terms of approach, one of them applies, one of them thinks he applies by 80%. G1 and G4 who think that they do not apply the program work at schools with low SES. Direct quotations that were gotten from teachers' opinions are as follows:

"... There are several factors that affect the application of the curriculum... it is not only about the teacher... I do not think that I apply..." (G1)

"I think I apply by 80%" (G5)

When teachers' opinions about the category of factors making application easier were investigated, it was founded that two of them use teacher guidance book in the application process of the program, one of them considers student exercise books as useful in terms of the application of the program. Direct quotations that were gotten from teachers' opinions are as follows:

"I apply the program on the basis of guidance book ..." (G2)

"I follow the guidance book in the application process..." (G3)

When teachers' opinions about the category of factors making application difficult were investigated, it was founded that two of them stated that the potentials of the school are not enough, two of them consider material insufficiency as a problem, two of them see laboratory as unavailable, two of them consider the crowdedness of the classes as a problem, two of them stated that the preparation process to SBS affects the application, and one of them considers the unconcernedness and economical problems of the parents as problems. Direct quotations that were gotten from teachers' opinions are as follows:

"... This problem is specific to our school, if we had a laboratory, materials, or a Science and Technology class, I would be able to apply the program better ..." (G6)

- Teachers' Opinions About The Positive And Negative Aspects In The Application Process Of The Program

Teachers' opinions about the positive and negative aspects in the application process of the program were shown in Table 8.

Table 8. Teachers' opinions about the positive and negative aspects in the application process of the program

Teachers	School SES	Themes (categories)	
		Positive	**Negative**
G1	Low	It is better to be student- centered It is superior to the old curriculum	The time is not sufficient Exam subjects are not taken place Subjects are very superficial
G2	High	I think that positive aspects are more than negative ones In general, the program is better, it can be applied I am satisfied with the program It is better than the old one It is suitable for student level It is suitable for schools	Material insufficiency is a problem Time is not sufficient Some units are very extensive Individual differences create problems
G3	Middle	It is better to be student- centered Being superficial of the subjects prevent students to be bored It encourage students to think and research Being spiral of the program is good	Time is not sufficient Activities foreseen in the program are too much for students' capacity
G4	Low	I think that it has positive aspects as compared to the old one	Material insufficiency is a problem Time is not sufficient Individual differences create problems The crowdedness of the classes is a problem Students' unpreparedness for lessons is a problem SBS and the exams city- wide are problems Parents do not have awareness It is difficult for some students to reach resources
G5	High	I am satisfied with the program It is better than the old one It is more current than the old one	Some units are extensive The crowdedness of the classes is a problem SBS exam and other exams city-wide are problems
G6	Middle	I think positive aspects are more than negative ones It is better than the old one It is suitable for student level It is more current than the old one Being spiral of the program is good Students are more likely to love Science and Technology lesson compared to the past	The material insufficiency is a problem Time is insufficient Students' unpreparedness for classes is a problem

As shown in Table 8, teachers' opinions were gathered into two categories, namely "Positive," and "Negative."

When teachers' opinions in the category of positive aspect were investigated, it was founded that four of them consider the curriculum better than the old one, two of them stated that being student- centered is well, two of them pointed out that positive aspects are more than the negative ones, two of them are satisfied with the program, two of them consider the program as appropriate for student level, two of them consider being spiral as a good thing, two of them stated that new program is more current than the old one, one of them stated that the

program is better, it can be applied, one of them mentioned that being superficial prevent students to be bored, and make students think and research, and one of them stated that students are more likely to love Science and Technology course compared to the past. Direct quotations that were gotten from teachers' opinions are as follows:

"… In terms of positive aspects, it is better than the old one by %80-%90. Being student- centered, activities, different teaching methods are good…" (G1)

"… The program has positive aspects as compared to the old one but…" (G4)

"… Program is better than the old one. I am satisfied with the program. Its intensity is decreased compared to the past. The old program based upon the formulas, problem- solving. Now, it based upon commentary, observation, and it is more current…" (G5)

Teachers' opinions about positive aspects of the curriculum are supported by researches. Researches indicated that teachers' opinions about the curriculum focus on the easiness of its applicability (Probart, McDonnell, Achterberg ve Anger, 1997), its application in the current circumstances (Dellalbaşı, 2010), its being spiral (Ayvacı ve Devecioğlu, 2009; Sert, 2008). The subject intensity decreased (Ercan ve Akbaba-Altun, 2005). Thus, teachers are satisfied with the program. In terms of student perspective, it was founded that program is student-centered (Tüysüz ve Aydın, 2009; Aydın ve Çakıroğlu, 2010), it is appropriate for student level (Dellalbaşı, 2010; Ayvacı ve Devecioğlu, 2009; Tüysüz ve Aydın, 2009), it is current and has an interaction to real life (Tekbıyık ve Akdeniz, 2008; Ayvacı ve Devecioğlu, 2009), it allows students to learn with doing, experiencing, thinking (Sert, 2008; Yıldırım ve Dönmez, 2008), it encourages students to do research and think critically (Çınar, Teyfur ve Teyfur, 2006; Selvi, 2006), it is interesting and attention getting (Tekbıyık ve Akdeniz, 2008; Kurtuluş ve Çavdar, 2011). Hence, students are more likely to love Science and Technology course now.

When teachers' opinions about negative aspects of the curriculum were investigated, it was founded that five of them stated that time is insufficient, two of them stated that materials are insufficient, two of them consider individual differences as problem, two of them consider some units as intensive, two of them see crowdedness of the classes as problem, two of them regard student' unpreparedness as problem, two of them consider the preparation process in SBS exam and city-wide exams as problems, one of them stated that in the curriculum exam subjects do not take place, and subjects are very superficial, one of them mentioned that activities in the curriculum surpass students' capacity, one of them stated that parents do not have awareness, and finally it is difficult to reach sources for students who are not capable of. Direct quotations that were gotten from teachers' opinions are as follows:

"In terms of negative aspects, time is not sufficient for all activities. Formal lecture, answering questions, and experiments cannot be finished in a 4 hour- period. Topics are too much disjointed, and they cannot be put together… in terms of subjects, there is not enough details. Exam subjects do not take place in the course book. There is no summary section in the course book. The important aspects about subjects do not take place in the course book. Subjects are too superficial…" (G1)

"…In terms of negative aspects, if we tried to do all activities we would be in trouble in terms of time. In addition, doing all activities in the curriculum surpass students' level." (G3)

Teachers' opinions about negative aspects of the curriculum are supported by researches. Studies show that time is not enough in terms of doing activities, and using testing and measurement techniques foreseen in the curriculum (Doğan, 2009; Yıldırım ve Dönmez, 2008; Sert, 2008; Erdoğan, 2007; Bantwini, 2010; Güneş, Şener-Dilek, Hoplan ve Güneş, 2012). The curriculum cannot be implemented because of material, equipment insufficiencies in schools (Tekbıyık ve Akdeniz, 2008; Ayvacı ve Devecioğlu, 2009; Aydın ve Çakıroğlu, 2010; Kurtuluş ve Çavdar, 2011). Moreover, the classes are too crowded (Doğan, 2009; Tüysüz ve Aydın, 2009; Adıgüzel, 2009; Bantwini, 2010; Ersoy, 2008; Delllbaşı, 2010; Okur, 2008), the content is too intensive, the number of activities, and gains are too much (Güneş, Şener-Dilek, Hoplan ve Güneş, 2012; Tekbıyık ve Akdeniz, 2008; Sert, 2008). The content is too superficial (Sert, 2008; Güneş, Şener-Dilek, Hoplan ve Güneş, 2012), the subjects surpass students' level (Ayvacı ve Devecioğlu, 2009¸ Güneş, Şener-Dilek, Hoplan ve Güneş, 2012), the content is not balanced with the exams in city- wide (Karaer, 2006; Sert, 2008).

If negative aspects in terms of students are considered, students tend to study in accordance with SBS exam (Özden ve Tekin, 2006); they do not do projects and performance home works (Özdemir, 2007; Dellalbaşı, 2010). Furthermore, projects surpass students' levels (Tabak, 2007), and students cannot do activities that aim to process knowledge (Adıgüzel, 2009).

Negative aspects of the curriculum in terms of parents are as follows: parents' teaching perspective focus on SBS, and they cannot change their habits (Aydın ve Çakıroğlu 2010). Parents do not have awareness and attention (Adıgüzel, 2009; Doğan, 2009; Bantwini 2010), their SES are low (Aydın ve Çakıroğlu, 2010; Özdemir, 2007). Thus, they cannot add too much thing to their children.

Besides to aforementioned factors, studies indicated that substructure, equipments, and opportunities in schools are not enough (Erdoğan, 2007; Yıldırım ve Dönmez, 2008; Ercan, 2007). Similarly, the physical conditions of classes are not suitable (Tekbıyık ve Akdeniz, 2008; Doğan, 2009; Güneş, Şener-Dilek, Hoplan ve

Güneş, 2012), the school environments are negative (Hardal-Ateş ve Aşçı-Akdağ, 2006; Bağdatlı, 2005). The teaching environment is insufficient for student- centered applications (Bulut, 2008; Erdoğan, 2007); there is insufficiency in laboratories in schools (Tabak, 2007; İzci, Özden ve Tekin, 2006; Kesercioğlu, Türkoğuz, Kılınç ve Toprak, 2006). Moreover, new methods and techniques cannot be used (Gündoğar, 2006; Bantwini, 2010), students' active participation cannot be achieved (Tekbıyık ve Akdeniz, 2008; Tabak, 2007), activities cannot be implemented (Kurtuluş ve Çavdar, 2011; Wood, 2001). Besides, some activities are under the level of students (Aydın ve Çakıroğlu, 2010; Kurtuluş ve Çavdar, 2011).

Conclusion and Suggestions

In general, it is obvious that teachers cannot implement the curriculum of Science and Technology course in classes. In order to compensate shortcomings in the application process, followings are suggested:

1. There should be some amendment in the physical conditions of schools and classes. By focusing on SES factor, teachers should determine insufficiencies in their own classes, and those should be compensated.
2. Materials that are needed for the application of activities foreseen in the curriculum should be gathered, and should be supplied to each school in the form of boxes. Those boxes should be gathered according to class, units, and subjects and they should be enough for the whole semester.
3. Teaching seminars should be organized during the semester in accordance with teachers' desires, demands, and opinions about the implementation of the curriculum.
4. For the application based Science and Technology course, the elements of the curriculum should be revised and its intensity should be minimized.
5. Duration of lessons should be revised and time management problem should be solved. The duration may be divided into three categories, namely course hour, activity hour, testing and measurement hour, which is similar to reading hour, guidance hour in schools.

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Thermal behavior of mechanically activated sepiolite

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Abstract: Sepiolite, a complex magnesium silicate mineral, was activated mechanically in a planetary mill and the changes in the mineral structure and thermal behavior of sepiolite were investigated by means of X-ray diffraction (XRD), scanning electron microscopy (SEM) and thermal analysis (TG-DTA). The results showed that particle size decreased and amorphization in the ore structure was occured with increment of grinding times. The loss of zeolitic water in the structure was actualized during mechanical activation of sepiolite.

Key words: Sepiolite, mechanical activation, thermal behavior.

Introduction

Sepiolite is a natural hydrated magnesium silicate clay mineral and its structural formula can be written as $Mg_8Si_{12}O_{30}(OH)_4(OH_2)_4.xH_2O$, (x=6-8) (Mora et al., 2010). Three pyroxene-type chains $(SiO_3)^{2-}$ exist in the structure and oxygen links the chains together so that doubly linked chains occur. This structural formation causes zeolite-like channels (Frost et al., 2003). Octahedral coordinated magnesium locates between the silica sheets (Mora et al., 2010). Water molecules that present in the sepiolite structure have been grouped into zeolitic water, bound water and hydroxyl water (Nagata et al., 1974). From the formula (OH) indicates the hydroxyl group, (OH_2) represent the bound (crystal) water and H_2O shows the zeolitic water (Mora et al., 2010). The surface of this mineral has silanol (Si-O) groups because of the discontinuity of the external silica sheets (Alkan et al., 2005). This formation play important role at the adsorption of organics on the clay surface. Furthermore sepiolites can be used as absorbents for cleaning gas and liquids (Can, 1992) wherefore its zeolitic channels that may be filled with water or organic molecules (Frost et al., 2003). Apart from this new utilization opportunities are constituted by different studies like usage for decolorization of sugar juice (Ünal et al., 1998) sulfur recovery from sour gas or hydrogenation activity on Ni supported on sepiolite (Jung et al., 2004) etc.

Several research that mainly concentrated on calcinations process have been made for explain the water type or transformation and interrelated temperature intervals by means of XRD (Bastida et al., 2006), DTA-TG (Frost et al., 2003) and FT-IR (Mora et al., 2010; Alkan et al., 2005) etc. Grinding process is a very common process in industry (Cornejo et al., 1988) but when mechanical activation process is performed size reduction, surface activation, chemical or decomposition reactions which take place above room temperature, occur simultaneously (Balaz, 2000). For this reason, in this study, the effects of mechanical activation on the structure and thermal behavior of sepiolitic clay were investigated by means of X-ray diffraction (XRD), particle size analysis, scanning electron microscopy (SEM) and thermal analysis (TG/DTA).

Materials and Method

The mechanical activation of sepiolite from Kale Maden (Turkey) was performed in a Planetary Mono Mill Pulverisette 6 under the following conditions: the weight and diameter of tungsten carbide (WC) balls were 200 g and 10 mm respectively; the grinding bowl was 250 mL WC; the grinding times 30 and 60 min; the speed of the main disk was 600 $rev.min^{-1}$; the grinding process was dry. Ball-to-mass ratios during mechanical activation were kept constant at 25.

For comparative study calcination was performed under atmospheric condition at 380, 540 and 580°C for one hour with 10°C/min heating rate. X-ray diffraction analysis was performed using a Rigaku Ultima X-ray

diffractometer and Cu Kα radiation. The degree of amorphization (A) of the mechanically activated sepiolite according to X-ray diffracton results was calculated from equation (1),

$$A = \left(1 - \frac{I_x B_0}{I_0 B_x}\right).100 \quad (1)$$

where I_0 is the integral intensity of the diffraction peak for the non-activated sepiolite, B_0 is the background of the diffraction peak for the non-activated sepiolite, and I_x and B_x are the equivalent values for the activated sepiolite (Balaz, 2000; Balaz, 2008). A JEOL 6060 LV scanning electron microscope (SEM) was used for morphological analysis of the non-activated and activated samples. DTA was performed using TA Instruments SDTQ 600 at heating rate of 10°C.min^{-1} under atmospheric conditions and Mikrotrac S3500 was used for particle size distribution analysis.

Results and Discussion

Chemical composition of sepiolite which was provided by Kale Maden (Çanakkale/Turkey) was given at Table 1. As seen from the table sepiolite is rich in silicon and magnesium. Lost on ignition value is only 11.74.

Table 1. Chemical composition of sepiolite

SiO_2	Al_2O_3	TiO_2	Fe_2O_3	CaO	MgO	Na_2O	K_2O	L.O.I
61.03	7.50	0.20	0.95	1.60	16	0.21	0.48	11.74

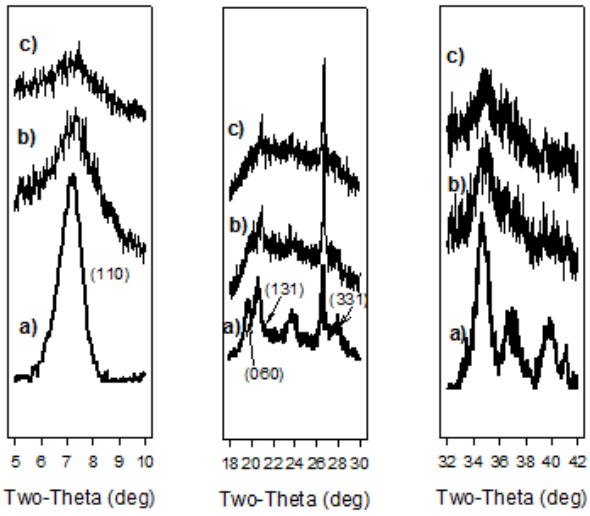


Figure 1. XRD patterns of (a) non-activated sepiolite, (b) activated for 30 min and (c) activated for 60 min

XRD patterns of the mechanically activated sepiolite samples were given in Fig 1. with respect to 5°-10° and 18°-30° and 32°-42° intervals. (110), (060), (131) and (331) reflections were determined at 7,2°,19.7°, 20.6° and 28° respectively for non-activated sepiolite. According to Eq 1, amorphization degree of the peak that found at 7.2° reached 98 percent after 60 min mechanical activation. Amorphization is the situation that peak broadening and decreasing of intensity come along because of the grinding media interaction and material behavior against this media. Particles can be refined at critical size and after this energy accumulation in the volume or at the surface of crystals take place. This occurrence is the beginning of the amorphization. Furthermore because of the interaction local temperatures may be increased (Tunç et al., 2012a; Balaz, 2000; Tunç et al., 2000b). (060) reflection got amorphized approximately 95 percent at 30 min and got lost after this duration. (131) reflection that positioned at 20.6 got

amorphized 76 percent after 30 min and stabilized. (331) reflection couldn't be determined for 30 and 60 min activated samples so it can be said that amorphization process took place and finished between 0 and 15 min for this pattern.. Between 32°-42° same amorphization degrees were calculated. According to this values average degrees are 89.9 and 92.3 percentages for 30 and 60 min. respectively. Amorphization degrees for the reflections and average value for mechanically activated sepiolite were given in Fig 2. as graphically. Intensity of the (110) reflection decreased greater than the others in 30 min. After 30 min decreasing behavior of the all peaks are the same. This is the result that originated from first structural ribbons deformation and after atomic structure disruption (Cornejo et al., 1988).

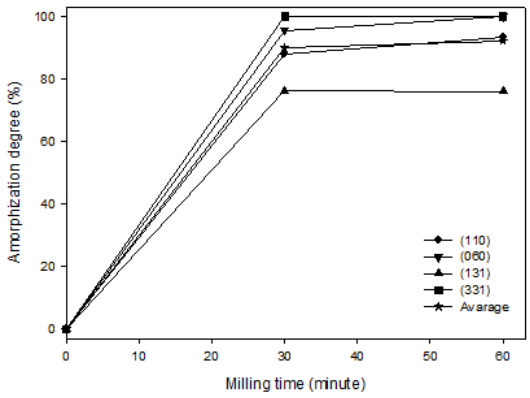


Figure 2. Amorphization degree of mechanically activated sepiolite

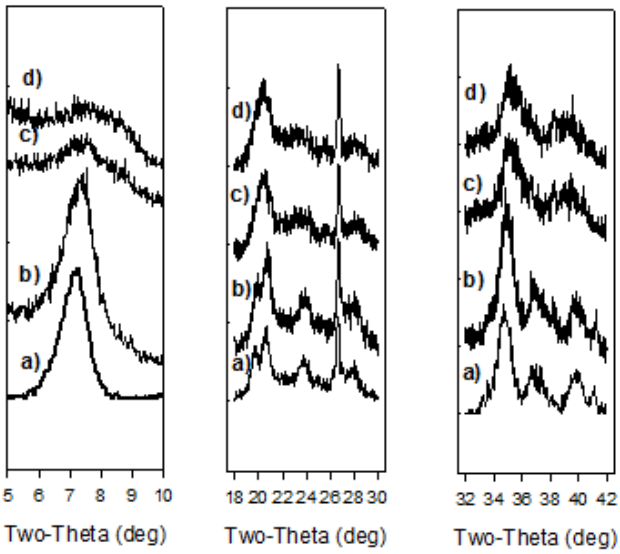


Figure 3. XRD patterns of the a) original sepiolite and calcined at b)380°C c)540°C and d)580°C sepiolite samples

Untreated sepiolite has sharp (110) = 12.1Å reflection that indicate the crystallinity of the sample as shown in Fig. 1 and Fig. 3. (110) diffraction pattern is the interlayer distance in sepiolite (Mora et al., 2010). After calcinig at 380°C, (110) diffraction preserved itself in some degree. But after calcinig at 540°c and 580 °C this peak disappeared and the structure of sepiolite was destroyed as took place in mechanical activation process.

Particle size analysis and SEM microscopy results were given in Table 2 and Fig. 4-6 respectively. Non-activated sepiolite has laminar structure and angled particles can be seen in Fig. 5. Diameter of the ninety percentages of the particles is 270.6 µm. In Fig. 5 and 6 instead of angled particle rounded particles were seen. Mechanically activated samples refined from this dimension to 37.89 and 94.13 for 30 and 60 min. activation duration respectively.

Table 2. Particle size analysis of the samples

Milling Duration (min)	d_{10} (µm)	d_{50}(µm)	d_{90} (µm)
Non-activated	3,660	175,7	270,6
30	0,688	2,834	37,89
60	0,701	3,930	94,13

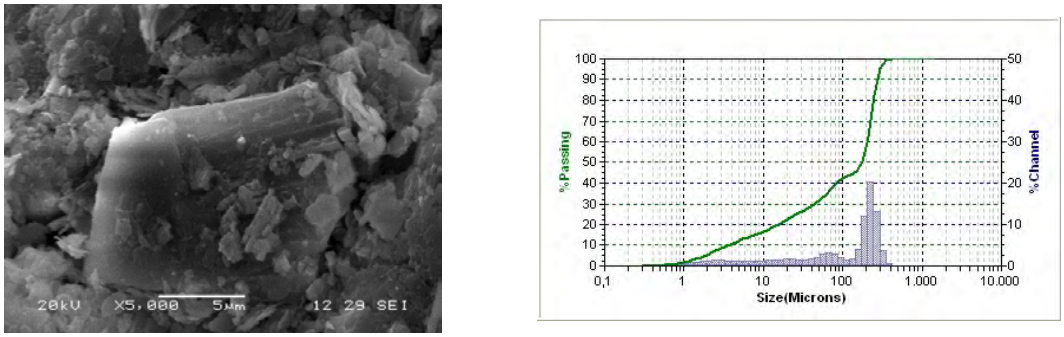
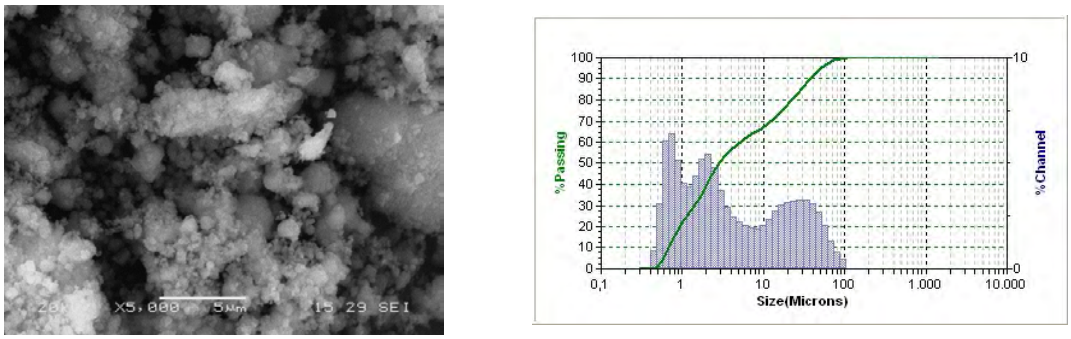


Figure 4. SEM micrograph and particle size analysis of non-activated sepiolite



.**Figure 5.** SEM micrograph and particle size analysis of activated sepiolite for 30 min.

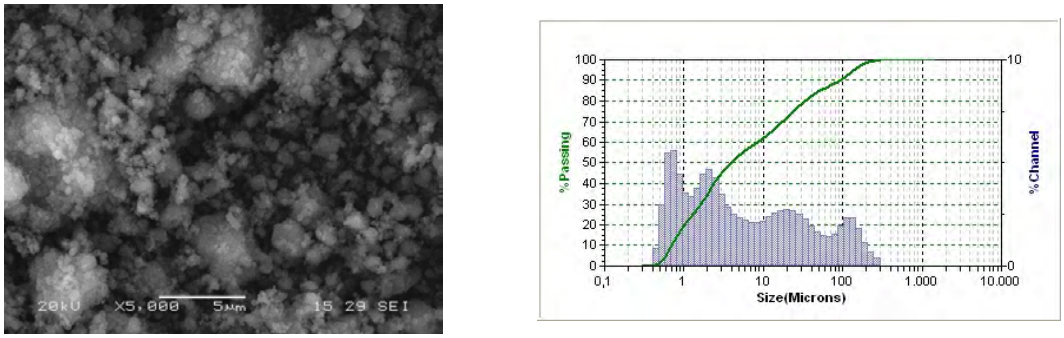


Figure 6. SEM micrograph and particle size analysis of activated sepiolite for 60 min.

The reason of increment in the dimension can be agglomeration that induced by mechanical activation which might be produced new surface area and this area can be more active than the former one (Balaz, 2008).

Thermal analysis of non-activated and activated samples was given in Fig 7. and Fig 8. with respect to thermogravimetric and differantial thermal analysis. Curve of the non-activated sample has four parts that have different slopes. These slopes can characterize the process rapidity (Nagata et al., 1974). Frost and Ding (2003) stated that up to 200C both hygroscopic and zeolitic water were lost. Between 250 and 450°C bound water were lost; more strongly bound water (co-ordinated water) and the hydroxyl units were lost in the temperature range 450-610°C. From these chemical equations theoretical weight loses determined as %11.1, %2.78, % 2.78, % 2.78 for each step respectively (Nagata et al., 1974). From this values and chemical equations step one and two are dehydration and step three and four are the dehydroxylation process (Frost et al., 2003).

Step I $Mg_8Si_{12}O_{30}(OH)_4(H_2O)_4.8H_2O \leftrightarrow Mg_8Si_{12}O_{30}(OH)_4(H_2O)_4 + 8H_2O$

Step II $Mg_8Si_{12}O_{30}(OH)_4(H_2O)_4 \leftrightarrow Mg_8Si_{12}O_{30}(OH)_4(H_2O)_2 + 2H_2O$

Step III $Mg_8Si_{12}O_{30}(OH)_4(H_2O)_2 \rightarrow Mg_8Si_{12}O_{30}(OH)_4 + 2H_2O$

Step IV $Mg_8Si_{12}O_{30}(OH)_4 \rightarrow Mg_8Si_{12}O_{30} + 2H_2O$

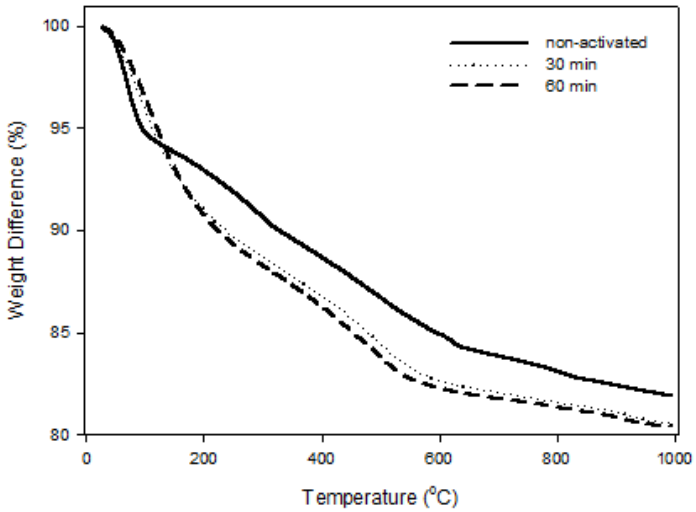


Figure 7. Thermogravimetric analysis of non-activated and activated sepiolite samples

For non-activated and activated sepiolite samples temperature intervals and related weight loses were given in Table 3. As seen from the table for non-activated sepiolite dehydration process did not completed in two steps with regards to hygroscopic and zeolitic water. In step three weight losses originated from residuary zeolitic water and part of the bound water were occurred. Similarly dehydroxylation process came after the loose of zeolitic water and did not completed end of the step four. In spite of non-activated sepiolite, dehydration occurrence finished in step one and dehydroxylation process occurred in step two as shown in Table 1 with regard to weight lost value. Step two and three are the dehydroxylation process for activated samples.

Table 3. Temperature intervals and weight loses for TG curves of the samples

	Step I	WL	Step II	WL	Step III	WL	Step IV	WL
Non-Activated	0-220°C	7.47	220-320°C	2.39	320-660°C	5,94	660-840°C	1.46
30 min.	0-400°C	13.17	400-580°C	3.97	580-1000°C	2.31	-	-
60 min.	0-380°C	13.3	380-560°C	4.07	560-1000°C	2.23	-	-

*WL=Weight Lost (%)

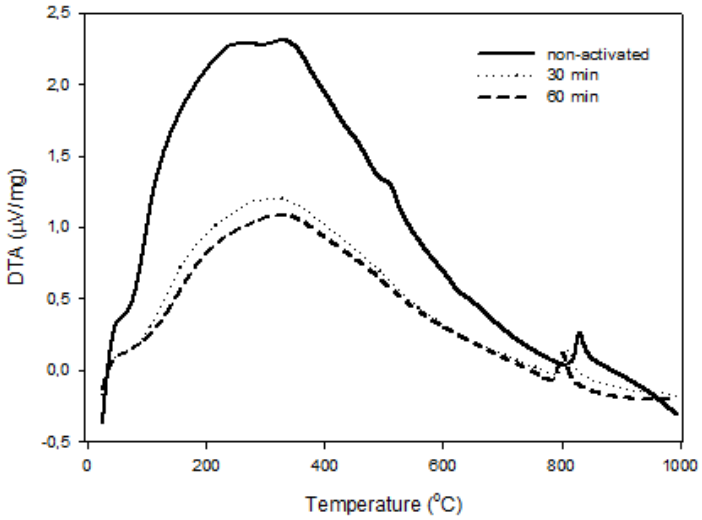


Figure 8. Differantial thermal analysis (DTA) of the samples

The area of the peak is proportional to the quantity of heat absorbed or released during reaction (Seguin, 1973). In Fig. 8 the area of the peaks are different and decreased with increment of milling time. From this result it can be said that with elongated mechanical activation time need of energy for dehydration, dehidraxilation and phase transformation decreased because of the energy accumulation in the volume or at the surface of crystal due to the limit for fragmentation of a partical (Balaz, 2000; Balaz, 2008). As seen from the Table 3 and Fig. 7 for activated sepiolite samples dehydration and dehydroxilation process occurred before of the reference temperatures. Identically transformation in to enstatite occurred at 830°C for non-activated sepiolite, 809°Cfor 30 min activated sepiolite and 801°C for 60 min sepiolite.

Conclusions

With mechanical activation the amorphization occurred in sepiolite structure and the structure was distorted. Dehidration was proceed in one step and dehydroxilation was completed in three steps. Transformation temperature was lowered after mechanical activation. Calcining sepiolite at 540°C gave same results with 60 min of mechanical activation with respect to amorphization that determined via X-ray diffraction analysis.

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Influence of Fermentation Condition and Alkali Treatment on the Porosity and Thickness of Bacterial Cellulose Membranes

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Abstract: The object of the present study was to produce bacterial cellulose (BC) membranes and studying the effect of carbon source, time and conditions of inoculation, type of alkali used for purification and the method of drying on it[s] porosity and thickness of the resultant membranes. *Acetobacter xylinum* was isolated from local rotten juice, and used for membrane production. The highest porosity was attained when sucrose was used as a source of carbon compared to glucose, fructose and glycerol. However, fructose, glucose and glycerol resulted in higher pH value for the medium used as medium for bacterial growth. Using glycerol as the sole carbon source gave the highest bacterial cellulose and biomass (g/l) as compared to glucose, fructose and sucrose. Small inoculation led to high porosities and lowest thickness of the resultant membranes. Porosity of membranes was affected by the type of alkali used for the purification of the membranes. Application of K_2CO_3 for purification gave the highest porosity while Na OH gave the lowest porosity. Hot air- drying of the membrane resulted in the lowest porosity as compared with freeze drying method which did not cause any damage to the porosity of the membrane.

Key words: Bacterial cellulose membrane, Thickness and porosity, *Acetobacter xylinum*

Introduction

Bacterial cellulose is a promising natural polymer belongs to specific products of primary metabolism (Retegi *et al*.2010). Cellulose is synthesized by bacteria belongs to the genera of *Acetobacter, Rhizobium, Agrobacterium, Psuedomonas* and *Sarcina* (Vu *et al*. 2008). Many strain of *A*. *xylinum* are capable of producing cellulose in varying amounts and growing on wide varieties of substrates like glucose, sucrose, fructose, invert sugar, ethanol and glycerol (White and Brown 1989). Cellulose production by *A*. *xylinum* had been noted both in static as well as agitated cultures (Chao *et al*. 2000).The most efficient producer is gram-negative and acetic acid bacteria , *Acetobacter xylinum* (reclassified as *Gluconobacter xylinum*) (Yamanaka *et al*.2000) .The bacteria was applied as a model microorganism for basic and applied studies on cellulose. *Acetobacter xylinum* is widely distributed in nature and is a common contaminant in the industrial production of vinegar by *Acetobacter aceti. Acetobacter xylinum* has been isolated from rotting fruits, vegetables and by fermenting coconut water (Jagannath *et al*.2008).

Presently BC is receiving great attention and being widely investigated as a new type of scaffold material due to it[s] fine fiber net work, biocompatibility , high water holding capacity , high tensile strength (Putra *et al*.2008) , high crystalline , high degree of polymerization, high purity , elasticity, durability, non -toxic and non-allergic(Hei,1999,Backdahl *et al*.2006, Sherif and Kazuhiko 2006,El-Saied *et al*.2008,Liet *et al*.2009,Marzieh and Ali 2010,Denise *et al*.2011).

In food applications the BC was used as an additive, emulsifier, dietary fiber, edible preservative and as a barrier against bacterial growth (Pacheco *et al*. 2004, Denise *et al*. 2011). Recently, BC is used in many special

applications such as a scaffold for tissue engineering of cartilages and blood vessels (Yamanaka *et al*.1990, Klemn *et al*.1999,2001), as well as for artificial skin for temporary covering of wounds (Krystynowicz and Bieleck 2001). Purified and dried BC was converted to a membrane to be used in the separation processes such as ultrafilteration, gas permeation and vapor permeation, and used in paper manufacture (Luz *et al*.2006, Kuan et al.2009). We believe that culture conditions such as type of strain , temperature of growth , carbon source, pH and the method of gel purification weather it is done by chemical agent, concentration, temperature or exposition time possibly affected the physical properties of the resultant membranes.

The aim of the present work was to evaluate the effect of growth conditions and the methods of purification on some of physicochemical and transparent properties of the resultant membranes.

Materials and Methods:

1- Stock culture

The organism exploited for the production of cellulose in this study was a strain of *Acetobacter xylinum* AJ_3 , which was isolated from local rotten apple juice. The cultures were maintained on tomato agar slants and were reactivated every month.

Tomato medium was composed of 50 g/l glucose, 5g/l peptone, 5g/l yeast extract and 10% by volume tomato juice at pH 6.8. Stock cultures were stored at 5°C according to Marzieh and Ali (2010).

2- Inoculums preparation

A culture medium composed of 5% glucose, 0.5% peptone, 0.5% yeast extract, 0.27%sodium phosphate monobasic and 0.12% citric acid. This medium was autoclaved at 121°C for 15 minutes. After cooling to room temperature, the medium was inoculated with 2.5 ml of the stock culture and incubated in a shaker incubator with the use of 200 rpm set at 30°C for 24h and pH 6.8. The organisms were harvested by centrifugation at 10000 rpm for 30 min and re-suspended in liquid medium to prepare the suspension of bacteria.

3- Membranes formation

Membranes were prepared using different carbon sources including glucose, fructose, sucrose or glycerol (35g/l) with 10g/l yeast extract, 7.5g/l peptone, 10g/l disodium phosphate and 10 ml/l acetic acid. The media was autoclaved at 121°C for 15 minutes, inoculated with 6% of the previously prepared bacteria and incubated at 30 °C for 8 days.

The effect of incubation period was studied using mediums contained glucose as carbon source using 6%of inculcation volume from the fermentation medium after (2, 4, 6, and 8) days. Membranes were also prepared using different percentages of inoculums (2, 4, 6, and 8%). Yield of cellulose, porosity and thickness of the resultant bacterial cellulose membranes were studied. The pH values for each medium were measured during fermentation.

4- Purification

After 8 days of cultivation, BC was harvested and purified by soaking in a solution of 0.5N NaOH at 90°C for 1h to remove the bacterial cell and other medium components. Then after, membranes were purified by Sodium hydroxide, potassium hydroxide, sodium carbonate or potassium carbonate to study it[s] effect on porosity of membranes. The purified bacterial cellulose membranes were then dried either in an air- drying oven at 80°C or by freeze- drying. Porosities of the dried bacterial cellulose membranes were determined, for membranes dried by either hot air or freeze drying methods.

Analytical methods

1- Measurement of biomass
After the incubation periods of 8 days, the culture broth was centrifuged at 3000 g for 20 min. The bacterial cellulose pellets were added to 90ml (0.1M) potassium acetate buffer (pH 5).Ten ml of 20% cellulolasse solution was added and incubated at 50°C with shaking at 100 rpm for 2h to hydrolyze BC (Kouda *et al*. 1997).Then, the resultant solution was centrifuged at 3000 g for 20 min. The precipitate was dried in an oven at 80°C over night and then weighted to determine the biomass.

2- Porosity
Porosity was calculated using the equation of Kidaoka *et al*. (1997):-
Porosity% = (wet weight – dry weight)/ (wet weight –weight in water) x100.
Dried bacterial cellulose membranes were soaked in deionizer water for more than 12h at room temperature, and the weight in water was measured by harnessing the sample in advice which suspended the sample in water (Mancini *et al*.2001).

3- Thickness
Thickness of each bacterial cellulose membrane was measured at ten different positions by a thickness gauge, and the values were averaged.

Results and discussion:

Effect of carbon sources on porosity of bacterial cellulose membranes

Figure (1) showed that the highest porosity (80%) of BC membrane was attained when sucrose was used as a source of carbon as compared to glucose, fructose and glycerol which gave lower percentage of porosity 70%, 66% and 65%, respectively. Nakai et al.(1991) warranted that because *A. xylinum* has no sucrose synthetase, therefore, at least four enzymatic steps in the path way from sucrose to get UDP- glucose. On the other hand using sucrose as the sole of carbon source led to limited growth of bacteria as compared to glucose (Table 1).Fewer amounts of microfibriles were produced, which explains the least cell mass, the lowest thickness with highest porosity. Bacterial cellulose membrane had the lowest porosity when glycerol was used as the sole carbon source. Table (1) showed that the lowest pH was attended when sucrose was used as a carbon source. However, fructose, glucose, and glycerol resulted higher pH values proportionally.

When glycerol was used as a source of carbon there might be no gluconic acid production during glycerol metabolism (Jonas and Farah 1998).It was found that when glycerol was used as the sole carbon source, the BC and biomass (g/l) were higher as compared with other carbon sources. The fibrils of BC from glycerol medium were entangled with each other resulting in a denser reticulated structure than those obtained from glucose medium (Jung *et al*.2010). When glucose was used as the sole carbon source, the BC yield and biomass were higher than that for other remaining carbon source. Due to these results and due to the availability of glucose, it was used as the sole carbon source during the following steps of this study.

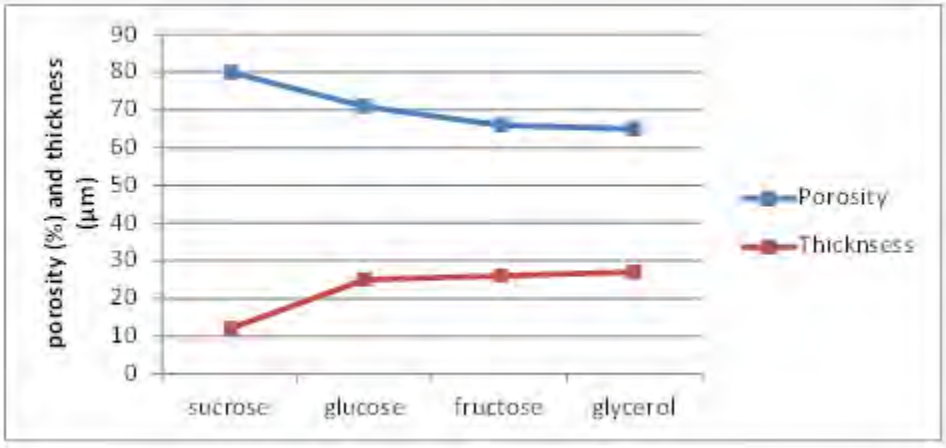

Figure 1. Effect of Carbon source on porosity and thickness of Bacterial Cellulose membrane produced after 8 days of cultivation with 5 % (v/v) inoculation volume

Table 1. The effect of carbon source on bacterial cellulose yield and biomass of *Acetobacter xylinum*.

Carbon source	Bacterial cellulose Yield(g/l)	Biomass (g/l)	Final pH
Sucrose	4.23	2.10	3.9
glucose	7.52	3.24	4.5
fructose	7.21	3.10	4.1
glycerol	8.52	4.50	5.2

Effect of inoculation volume on porosities and thickness of bacterial cellulose membranes

The effect of inoculation size on porosities and thicknesses of BC membranes is shown in figure 2. Small inoculation led to high porosities and lowest thickness of BC membranes. The results showed that the porosities of bacterial cellulose membranes dropped from 78% to 45% with increasing inoculation volume (v/v) from 2 to 8%.The results showed that the cell growth increased with increasing size of inoculums and that led to increasing BC production . Generally, the production of large number of micro fibrils often led to a compact structure and lower porosity for the BC membrane. This indicated the possibility of production of BC membrane which have wide range of porosity depending on the purpose of BC membrane applications.

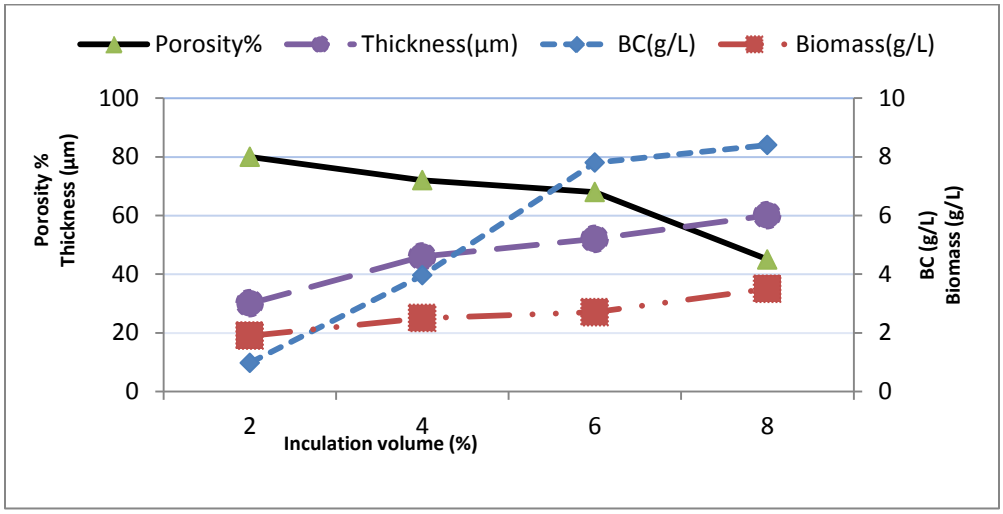

Fig. 2 Effect of inoculation volume on cell growth (Biomass) of *A. xylinum* , porosity, thickness and yields of the bacterial cellulose membranes

The Effect of culture time on porosity and thickness of bacterial cellulose membrane.

Figure 3 showed the effect of culture time on the porosity and thickness of bacterial cellulose membrane. In the first day of cultivation there was no cellulose production. During cultivation, the porosities of bacterial cellulose were decreased successively from the second day to the end of incubation period of 8 days. During cultivation, the yield of BC, cell mass and thickness were increased with increasing time of culture growth, but porosities were decreased due to the accumulation of more fibrils. The secreted cellulose was randomly deposited behind the moving micro-organism to produce certain porosity of cellulose membranes with three – dimensional network. The movement of single cells was caused by the inverse forces of the secretion of cellulose nano fibers. (Hesse and Kondo 2008).

Watanabe and Yamanaka (1995) found that oxygen tension in the gaseous phase under static culture conditions affected network formation of BC, and the density of network in the gelatinous membrane could be controlled. Then by changing oxygen tension we can produce bacterial cellulose membranes with the desired porosities for various applications.

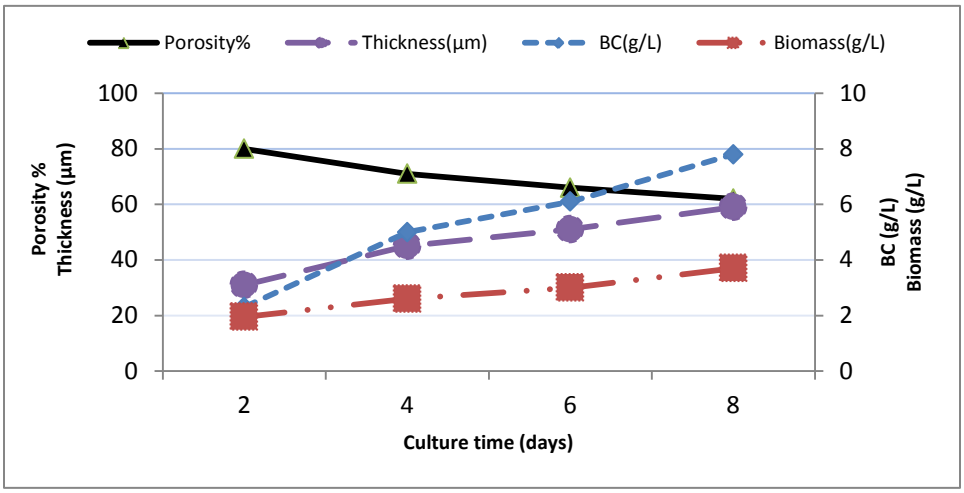

Fig. 3 Effect of culture time on porosity, thickness, yields, of bacterial cellulose Membranes and cell growth (Biomass) of *A. xylinum* AJ3 with inoculation volume of 6% .

Effect of alkali treatment on porosities of bacterial cellulose membranes

Treating bacterial cellulose membranes with various alkaline solutions resulted in increases in the porosity of the membranes (Figure 4).These results indicated that the diameter of membrane's fibrils were affected by alkaline solution in a degree depending on of alkaline solution. Porosities of bacterial cellulose membranes were found to be depending also on the type of alkaline solution and it showed different porosity arranged in descending as K_2CO_3 > Na_2CO_3 > KOH > NaOH. The diameter of NaOH – treated ribbons of BC which had the lowest porosity was in a range of 45 – 130 nm as measured by using microscope stage micrometer, while for K_2CO_3 treated ribbons of BC had the highest porosity and was in a range of 25 – 110 nm. Differences in porosities of BC treated with different alkali probably gave higher swelling fibrils of BC. These results were due to increases in diameter of fibrils especially the membrane that was treated with NaOH, thus effective pore size available in the membranes. (George et al. 2005, Brigid et al. 2009, Weihua et al.2010). By using different alkali treatments resulted in membranes having different porosity which lead to a wide range of membrane applications in the laboratories and in industry.

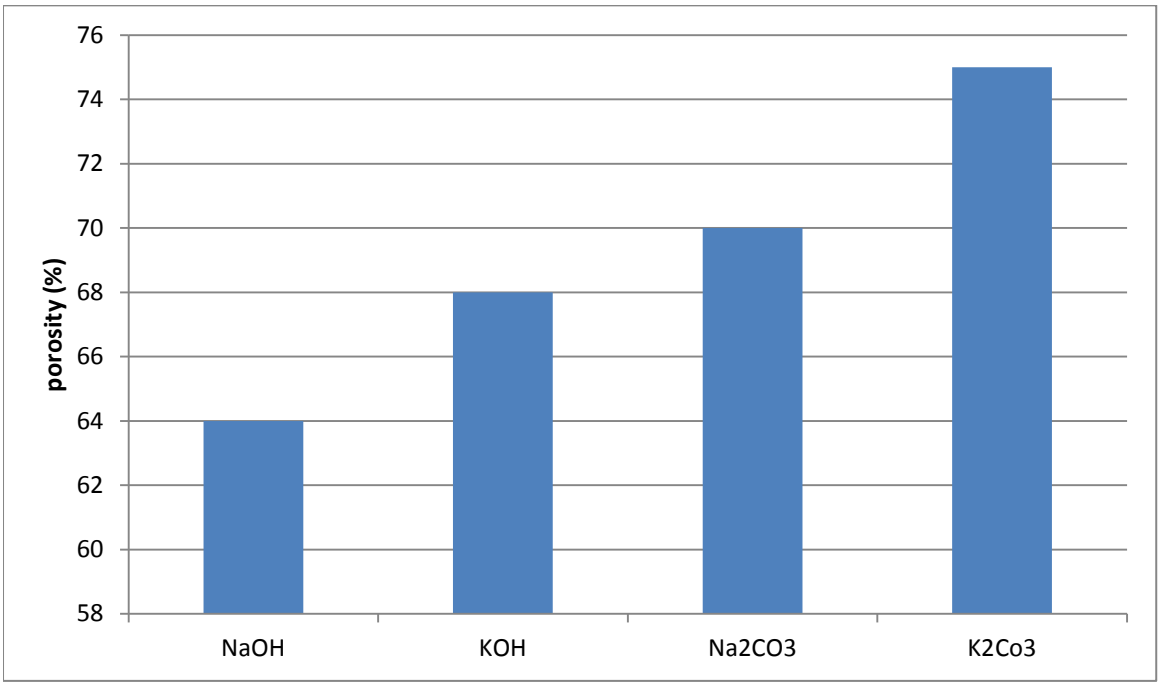

Fig-4- Porosity of bacterial cellulose membranse treated with different alki solution.

Effect of drying method on porosities of bacterial cellulose membranes:

Method of drying of BC membranes affected porosity of the membrane. Membranes which were dried by hot air had the lowest porosity (62%) as compared to freeze – drying method (88%) (Fig. 5). Freeze – drying was effective in preventing the shrinkage of pores during drying (Marabi and Saguy 2004, Svensson *et al*. 2008).The collapse was very severe when hot air drying was used for drying of the high water content materials of the membrane, while the collapse was usually negligible when freeze drying method was used for drying similar membranes (Karathanos *et al*. 1996).

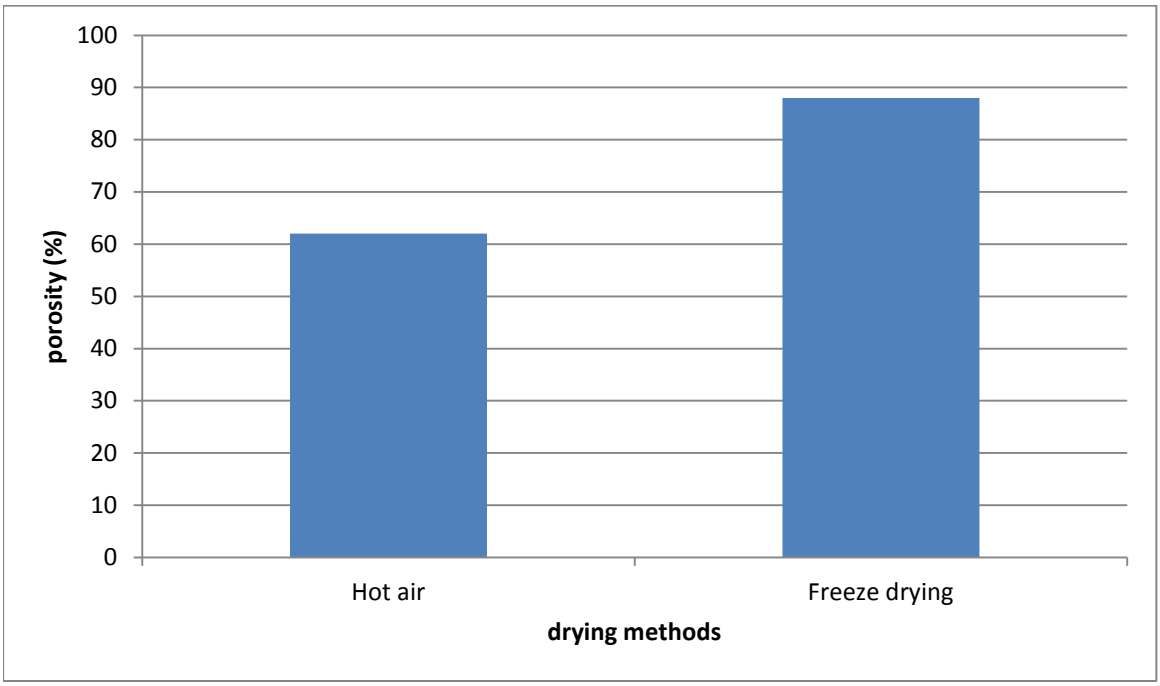

Fig. 5 Effect of drying method on porosity of bacterial cellulose membranes.

Conclusions

This work indicated the possibility of getting the required porosity and thickness by varying the production media and purification conditions. It is also concluded that bacterial cellulose production as a polymer is very wide field for further studies and investment. It is also economical to produce it from local date syrup and molasses.

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