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# Teaching The Linear Function in Secondary Education With The Use of New Technologies

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***Abstract*— In the teaching of the subject of Mathematics and in particular, in the teaching of the linear function f(x) = ax + b, the use of Microsoft Office Excel programme ( 1st grade of Eniaio Lykeio/ Unified upper-secondary school) equally facilitates both participants of the learning process, as the particular programme is incorporated in the context of the learner-centered educational procedure. Within the framework of this point of view and with the aim of effectively compiling the syllabus, the application of twelve (12) basic principles hinging on the active participation of learners in mutual cooperation, is considered necessary. Self-evaluation and the need to establish specific incentives and set concrete aims and objectives constitute indicative examples of basic principles.**
**Within the frame of the afore-mentioned educational principles, it is suggested that the class is divided in groups of 2-3 students and new technologies are implemented (P/C), with the ultimate goal to clarify and comprehend concepts and applications relevant to the subject. Criteria for the design of such an activity are the exploitation of learners' background knowledge and experience as well as the experimental involvement in new teaching practices. As prerequisites, we pose the formulation of conjectures and conclusions and the 'de-penalization' of errors in the mind of learners.**

***Index Terms*— Education, Linear function, New Technologies, Teaching.**

## I. INTRODUCTION

In a traditional – teacher centered lesson, learners are taught definitions of concepts, theorems with their proofs, and finally conclusions, with the aim to solve exercises and mathematical problems [4, 5]. The tools employed to assist learners are: paper, pencil, ruler and a pair of compasses. The main disadvantage of the above tools is that, often, it is not possible to achieve accuracy in drawing or designing and as a result, fundamental geometrical principles are not disclosed. For the lesson we have chosen to deliver within the context of this assignment, we will make use of Microsoft Office Excel sheet.

A model lesson of the 1st grade of the Hellenic Eniaio Lykeio (Unified upper-secondary school) is included; more specifically, the paragraph *"the linear function f(x) = ax + b"*. The learner's worksheet, the teacher's worksheet as well as the Excel sheet in which learners can experiment under the guidance of the teacher, follow [13, 14, 15, 16, 17].

## II. PSYCHOLOGICAL- PEDAGOGICAL PRINCIPLES

This excel sheet resolves the lack-of-accuracy problem and facilitates learners' trials and conjectures. It also facilitates the disclosure, with ease and clarity, of the fundamental relations hidden in the figures. Excel helps the teacher to plan and implement certain educational activities of high standard which are oriented towards rich and fruitful teaching/ learning objectives hinging on the constructive model, that is, activities that focus on thinking and understanding rather than on mere drilling and barren memorization [2, 8].

The psychological principles described further down relate to education and recapitulate some of the significant findings of current research on learning. They make an attempt to incorporate researches from various fields of psychology such as educational, developmental, cognitive, social and clinical psychology. These researches have provided new ideas concerning the learning process and the evolution of knowledge in several fields of study. As a result, today, school curricula and the teaching process undergo transformations in an effort to become more learner- than teacher-centered, link school to real life conditions and focus on understanding and thinking rather than on memorization and merely drilling.

The 12 principles can be more easily comprehended if perceived as an organised unified whole where each principle supports the others. The principles are put forward as a unified framework for the designing of school curricula and teaching methods. Indeed, they are behind a number of innovative programmes in schools all over the world [6, 7].

We begin with the discussion of three principles which are widely acknowledged as the ground on which teachers should design the learning environments of modern school. That is, learning environments which encourage learners to actively participate in the learning process, cooperate with other learners and be involved in meaningful activities. Then, we proceed with seven principles which focus on cognitive factors that are basically internal, but also interact in significant ways with environmental factors. Teachers should take into consideration these principles so as to design more effective syllabi and teaching procedures. In the end, we discuss developmental and individual differences as well as the impact of motives on learning. These two last areas are very important for teaching and learning and they are worth being the focus of separate sheets so that they are adequately elaborated upon. The 12 principles are the following [1]:

1. Learning requires the active and constructive participation of the learner.

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2. Learning is primarily a social activity. Learner's participation in school social life is a prerequisite for learning to take place.
3. Learners learn more easily when they get involved in activities which they consider useful in real life and are related to their culture.
4. Learners' new knowledge is structured upon the basis of their beliefs and understandings.
5. Learning is enhanced and accelerated when students learn to employ effective and flexible strategies to resolve problems.
6. Learners should know how to plan and monitor their learning process, set their own objectives and rectify their errors.
7. Sometimes background knowledge can block the way towards new learning. Students should learn how to resolve internal conflicts and restructure the already existing concepts, whenever it is necessary.
8. Achieving learning is facilitated when the material used, hinges on general principles and explanations and does not rely on memorizing isolated facts and procedures.
9. Educators can enhance their students' ability to implement the knowledge gained in order to resolve real life problems.
10. Learning is a complex cognitive activity that demands no precipitation. A lot of time and practice are required for a skill to start being formed.
11. Research has shown that there are significant developmental learning differences among learners.
12. Learning is affected by the existence of incentives/motives on the part of the learner. Psychologists have distinguished between two types of motivation: a) extrinsic motivation and b) intrinsic motivation. Extrinsic motivation t is realized when positive methods of reinforcement are employed, such as rewards, high grades etc., while intrinsic motivation emerges when students fervently participate in meaningful activities without the need for any rewards. Teachers, thus, through their attitude and the tasks they bring into the lesson, can draw their students' attention and stimulate their interest so as to establish motivation which is an essential precondition for the realization of learning.

### *A. Learners in the P/C laboratories*

Given the fact that we rely on the afore mentioned psychological and pedagogical principles as well as on the potentials of Excel, we propose the following educational activity within the context of a two-hour teaching session in 1st grade, Eniaio Lykeio . It is recommended that the teacher divide the class in groups of two (2) to three (3) students and distribute the Learner Work Sheet that follows. Each group has their own P/C. We propose that the activity is realized in four (4) stages:

Stage I

The teacher gives instructions to the learners concerning Excel so that they experiment on the figure of the educational activity.

Stage II

Learners start working individually.

Stage III

In each group, learners exchange opinions. Whether the correct solution is reached or not, by any of the groups, is the last thing that should preoccupy the teacher.

Stage IV

An open discussion on the solutions of each matter takes place [9, 10].

### *B. Teaching/ learning aims: At Cognitive level*

Within the framework of the traditional teaching practice, the attempt to approach concepts, especially abstract concepts such as the 'straight line', which are not part of learners' direct and natural experience, is problematic. Thus, the development of incentives and the active character of learning are restricted. As a result, it is not possible to resolve cognitive conflict and structure new cognitive schemata. Nevertheless, the simplicity, the speed and the accuracy of the Excel program, in combination with its dynamic operation and its ability to demonstrate concepts, contribute to learners' familiarization with and comprehension of difficult-to-perceive concepts which constitute the primary aim of the activity mentioned [3, 11, 12].

Also, our aim is that learners:

1. Activate and make use of their prior knowledge regarding: a) the Pythagorean Theorem, b) the distance between two points, c) the concept of the tangent angle, d) the concept of the parallel lines and the concept of the perpendicular lines, e) the solution of an equation and f) the solution of a system of linear equations.
2. Understand the concept and function of a variable. Focal points are: a) the manner in which we select a variable, the reason for using it and what it represents, b) how a figure is transformed when an element of its structure changes due to the variable we have selected.
3. Feel the need to come up with one or more strategies in order to resolve a number of problems.

### *C. Implementation of New Technologies*

A parallel teaching objective of the activity is for learners to become familiar with the computer and practice basic calculating skills of the software. Thus, our goal is that learners, after understanding the basic commands of the main menu of the software, are able to:

1. work with the "mouse" as a tool of dynamic manipulation.
2. depict, in a system of rectangular axis, the graphic representation of the function f(x)=ax+b and interpret it.
3. save and retrieve their assignment.

## III. The Learning Process

The criteria for the planning of this educational activity include:

1. The activation and exploitation of learners' prior knowledge and experience.
2. Learners' direct manipulation of and experimentation with the figure as a result of the exploitation of their intuitive thought.
3. The notion according to which, the existence of a problem waiting to be solved, creates the need to

refer to Mathematics – without a problem, there is no need to be engaged in Mathematics.

4. The resolution of a problem creates the learning framework within which the learner structures Mathematical knowledge.
5. Learners contact with the methodology of conducting experiments, that is, with:
   a) the formulation of conjectures related to the intersection, the parallelism and the perpendicularity of two straight lines
   b) the checking of the pertinence of these conjectures
   c) their verification
   d) the formulation of conclusions.
6. Learners' need to invent a certain strategy as a methodology towards actively acquiring knowledge.
7. The studying of the 'straight line' concept
8. The cultivation of learners' analytical and synthetical thinking.
9. The creation of new pedagogical roles both for the teacher and the learners
10. Learners' engagement in procedures that promote cooperative learning and communication.
11. Learners' practice of skills concerning the expression of oral and written word.
12. The 'de-penalization' of the concept of error in the mind of the learners

## IV. Learner-Teacher Work Sheets, Excel Sheet

LEARNER WORK SHEET – Class: A΄ 1ST CYCLE

**The linear function f(x) = ax+b (§ 7.3)**

Open the **line1.xls** file (activate the macro instructions).

a) Complete the following table (Use boldly the scroll bars to change the values of the parameters a, b).

| x | -0,37 | 1,26 | a |
|---|---|---|---|
| y = 2,5x +1,4 | | | |
| y = 2,5x -1,4 | | | |
| y = -2,5x+1,4 | | | |
| y = -2,5x -1,4 | | | |
| y = 0x+2 = 2 | | | |

➢ Conclusion:

……
……

b) Examine whether the points A(-1, -1.1), B(-2, 3.6) and C(0.4, 2.4) belong to the straight line y = 2,5x +1,4. Justify your answers.

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c) Find the equation of the straight line that passes from the points A(2,4) and B(-2,16).

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a) Complete the following table:

| y = 2x+1 | |
|---|---|
| x = 0<br>y = | Geometric interpretation: |
| x =<br>y = 0 | Geometric interpretation: |
| **y = -2x+3** | |
| x = 0<br>y = | Geometric interpretation: |
| x =<br>y = 0 | Geometric interpretation: |

➢ Conclusion:

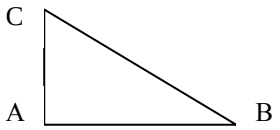
……

b) Do the lines $l_1$ and $l_2$, in figure 1, cross?
Make a conjecture

……

*For the following you can use the Windows Calculator.*
*[ Start > Accessories > Calculator (View: Scientific) ]*

Also, remember that in a right triangle *ABΓ (A=90°) apply:*




$$\tan B = \frac{AC}{AB}$$

If **y = 2,5x + 3,4** (line $\mathbf{l_1}$) find the points of its intersection with the axes and then with the angle $\mathbf{w_1}$ which is formed by $l_1$ and the axis x΄x.

| $a_1$ | intersection $l_1$ with xx' | intersection $l_1$ with yy' | tan $w_1$ | $w_1$ |
|---|---|---|---|---|
| | | | | |

If **y = 2,5x + 1,8** (line $\mathbf{l_2}$) find the points of its intersection with the axes and then with the angle $\mathbf{w_2}$ which is formed by $l_2$ and the axis x΄x.

| $a_2$ | intersection $l_2$ with xx' | intersection $l_2$ with yy' | tan $w_2$ | $w_2$ |
|---|---|---|---|---|
| | | | | |

If **y = - 0,4x + 1,2** (straight line $\mathbf{l_3}$) find the points of its intersection with the axes and then with the angle **φ** which is formed by $l_3$ and the axis x΄x.

| $a_3$ | intersection $l_3$ with xx΄ | intersection $l_3$ with yy΄ | tan φ | φ |
|---|---|---|---|---|

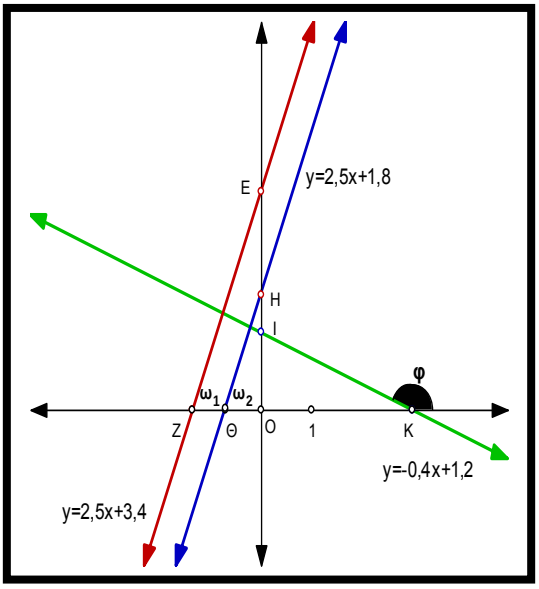



Figure 1

If w is the angle which is formed by the axis x´x and the line l, with equation y=ax+b, then complete the table based on the above:

| lines | w | tan w | a |
|---|---|---|---|
| l1 | | | |
| l2 | | | |

➢ Conclusion: What is the relation between the 'coefficient of direction' a and angle w?

7. If two lines are parallels, then the coefficients of direction of the lines are equal. Does the inverse apply; (figure 2) Make conjecture

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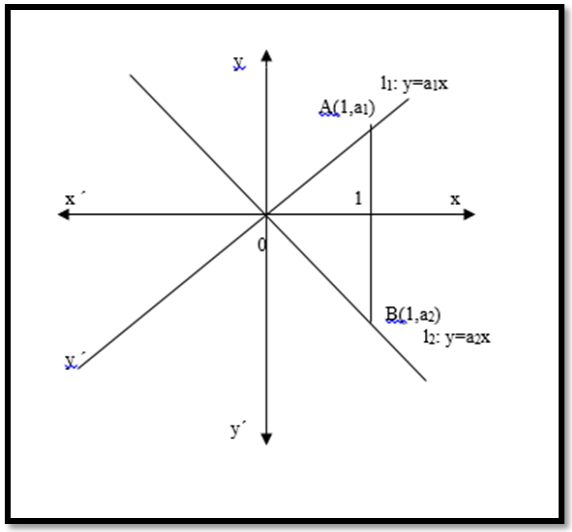


Figure 2

Find the angle which is formed by the straight line δ and the straight line l1 of figure 1.

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If two lines are perpendicular then the product of the coefficients of direction equals –1 and inversely (figure 2). Make a conjecture

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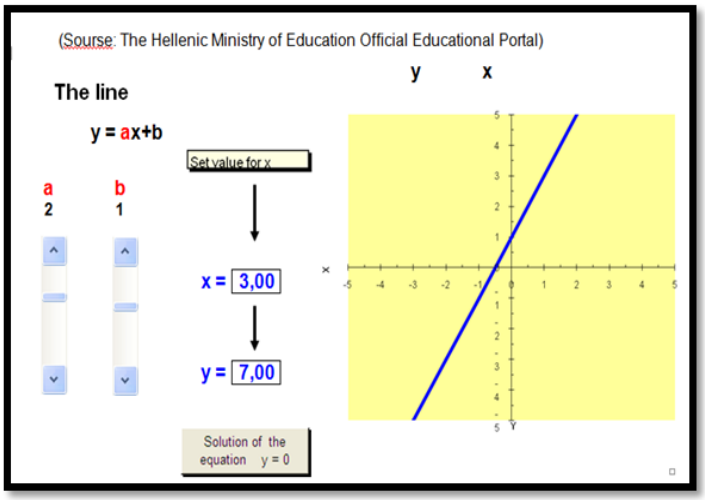


Figure 3
The **line1.xls** file

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