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Students' understanding and use of gradient in kinematic graphs
La comprensión y uso de gradiente por los estudiantes en los gráficos de la cinemática

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Abstract

The concept of gradient as an indicator of "rate of change" is crucial to the understanding and interpretation of any graphically represented data. This article investigates the degree to which students spontaneously focus on the gradient of a graph in order to obtain information about a motion or, alternatively, to construct a different but related graph. A brief summary of the finding of a number of researchers is followed by a report on an own empirical study involving 273 students. The results show that learners are extremely reluctant to employ the gradient concept in order to solve kinematic graphing problems. The main reason for this is that they seldom associate gradient with rate of change.

Key words*: gradient, kinematic graphs, rate of change, education of physics*

Resumen

El concepto de gradiente como un indicador de la razón de cambios es crucial en la comprensión e interpretación de cualquier representación de datos. Este artículo investiga el grado en que los estudiantes hacen su enfoque en la gradiente de un gráfico para obtener la información sobre un movimiento o, alternativamente, para construir un gráfico diferente pero relacionado. Un resumen breve de resultados de varios investigadores se sigue con un informe del propio estudio empírico que involucra a 273 estudiantes. Los resultados muestran que los aprendices son sumamente renuentes a emplear el concepto de gradiente para resolver los problemas gráficos de cinemática. La razón principal es que ellos raramente asocian la pendiente con la proporción de cambio.

Palabras clave*: gradiente, gráficos de cinemática, cambios, educación en física*

INTRODUCTION

The graphical representation of the relationship between variables is important, not only in mathematics and the physical sciences, but also the economic sciences and indeed in most other disciplines. It clearly shows the pattern between the variables and also critical values such as maxima and minima stand out immediately.

The gradient (or slope) of a linear or curvy-linear graph is a key concept because it gives the rate of change of the dependant variable that is being represented. Graphs thus provide an easy and accessible vehicle to properly analyze contextual problems that are encountered e.g. motion graphs (such as velocity-time) of a car traveling between two points..

This article investigates the extent to which students make use of gradient in order to analyze and interpret *kinematic* graphs. More specifically it investigates the degree to which students use *gradient* in order to translate from one kinematic graph to another representing the same physical phenomenon.

Some important research findings on the level of students' understanding and their willingness to apply the gradient concept are described. This is followed by a report on an empirical investigation, involving 273 students, into the degree to which students use gradient when having to deal with different kinematic graphs describing the same physical event.

STUDENTS' PERCEPTION OF GRADIENT AND RATE OF CHANGE

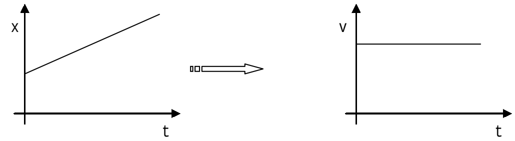
The gradient of a line is a fundamental concept in mathematics. It is used in algebra, trigonometry and calculus and is extensively used by teachers of physics as an indicator of rate of change. It is well documented that students (even those who have been exposed to pre-calculus physics) do not fully connect the concept of gradient with rate variations when constructing mathematical models of real-life situations. (Leinhardt, Zaslavsky and Stein, 1990; Clement 1989; Beichner, 1994; Confrey and Smith, 1994).

Bezuidenhout (1998) investigated first year calculus students understanding of the rate of change concept. He reports that due to inadequate intuition as well as poorly developed concept images, it is a concept that is particularly poorly understood by these students. When the rate of change concept has to be applied to graphs, students often experience serious difficulty. For example they often do not understand that it is possible, in the case of curvy-linear graphs that for every point on the graph the rate of change can have a different value (Orton, 1984; Beichner, 1994; Crawford and Scott, 2000). Typically students frequently compute the gradient at a point by dividing a single ordinate value by a single abscissa value (Beichner, 1994: 745).

Physics and mathematics educators have expressed serious concerns about students' apparent inability to connect graphs studied in mathematics and physics. McDermott, Rosenquist and Van Zee (1987: 503) found in this regard that *the problem students have with graphing cannot be simply attributed to inadequate preparation in mathematics. Frequently students who have no trouble plotting points and computing slopes cannot apply what they have learned about graphs from their study of mathematics to physics*.

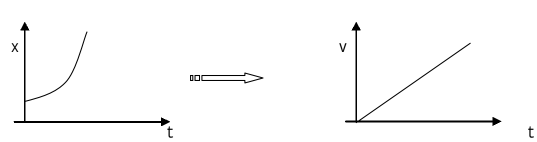
The study of kinematics, not only teaches students some of the key concepts associated with motion, but more importantly it provides a vehicle for students to gain a deeper understanding of graphs and their gradients. Students who are confident about their ability to determine slopes quickly and accurately are at a clear advantage as they continue their studies in mathematics and physics (Kennedy, 1997; Canderle, 1999).

McDermott, Rosenquist, Popp and Van Zee. (1983, 1987), Rosenquist and McDermott (1987) and Beichner (1994) found that students experience difficulty when selecting another corresponding graph when given a kinematic graph. One reason seems to be their inability to separate the *meanings* of position, velocity and acceleration vs. time graphs from each other. This caused a tendency among students to maintain the shape of the original graph because they find it difficult to accept that the same motion can be represented by graphs of widely different shapes. McDermott *et al.* (1983, 1987) report a particular tendency to draw incorrect *velocity vs. time* graphs that were very similar in shape to the *position-time* graph of the motion that was being demonstrated. They propose that the main reason



Moderate difficulty

Figure 1(a)



Serious difficulty

Figure 1 (b)

for this is that students seldom interpret the *velocity-time* graph as a plot of the **slope** of the *position-time* graph. The problem is compounded when the increasing slope of an *x-t* graph has to be translated into an increasing height of the corresponding *v-t* graph (see figure 1(b).

The association of a larger gradient with a higher rate of change of the physical quantity which is being graphed is often not understood (see for example Orton 1984 and Clement 1989). This is usually caused by a slope vs. height confusion on the part of the learner (Clement (1989:81). He quotes an experiment performed by Janvier (1978) to illustrate how the tendency to use heights of graphs when slopes should be focused on also manifests itself when a real-life situation is represented graphically.

Janvier (1978) showed students a graph of the height vs. time for the water level of a wide jar as it is being filled with water (see graph A of figure 2). He asked them to draw the corresponding graph for a narrower jar being filled from the same source. The idea was that students had to focus on the slope of graph A, which gives the rate at which the water level was increasing. Many students drew graph B (which is "higher" than the given graph) instead of graph C with increasing slope.

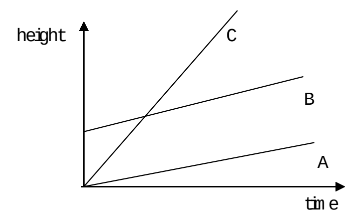


Figure 2

McDermott *et al.* (1987:504) report similar confusion between position and velocity of a graphically represented motion by a sample of science orientated college students. With reference to figure 3, they had to compare the velocities of two moving objects, A and B at various stages. As many as half the students stated, incorrectly, that at t = 2 s, the speed of object A is greater than that of object B and that they will have the same speed at t = 3 s.

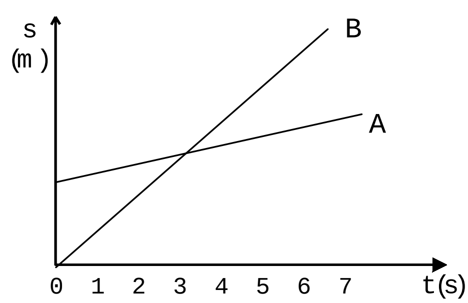


Figure 3

Clement (1989:80) generalizes the mistaken use of the graphical feature of height instead of slope as … *a mistaken link between a successfully isolated variable* (speed) *and an incorrect feature of a graph* (height). According to Clement they seem to have difficulty in associating the kinematic quantity of speed with the change in position of the object over time and hence cannot see that, compared to A, there is a greater change in position per time unit in graph B.

AIM AND METHODOLOGY OF THE EMPIRICAL STUDY

As part of a larger study into students' understanding of motion graphs, their comprehension of gradient and its use in both graph interpretation as well as construction tasks were investigated. A sample of 273 pre-calculus physics students ranging in academic level from Grade 11 and 12 to first year college, answered a free-response type questionnaire. A number of audio taped interviews were also conducted with students in order to gain additional insights into the way they thought about gradient. The interviews proved useful as they gave some indication of the root cause behind some commonly occurring misconceptions about the role of gradient in kinematic graphs.

The present investigation focuses on the *extent to which students were able to apply the gradient concept in order to carry out successful graph-graph transformations*. In other words how do students approach the problem of drawing different motion graphs when given a graph depicting a kinematic event. Before their graph -graph transformation skills were tested, it was deemed necessary to first find out to what extent the respondents understood:

- the meaning and significance of the concept of gradient in kinematics in general, and
- the meaning of the concepts of displacement, velocity and acceleration.

The following are examples of questions that the test group had to answer.

1. State briefly how you would explain the concepts of *displacement*, *velocity* and *acceleration* to a friend who has very little knowledge of science.
2 What information can be obtained from gradients in *displacement-time*, *velocity-time* and *acceleration-time* graphs?
3 Consider the graphs of figure 4 and write down the numbers of those with a negative gradient.

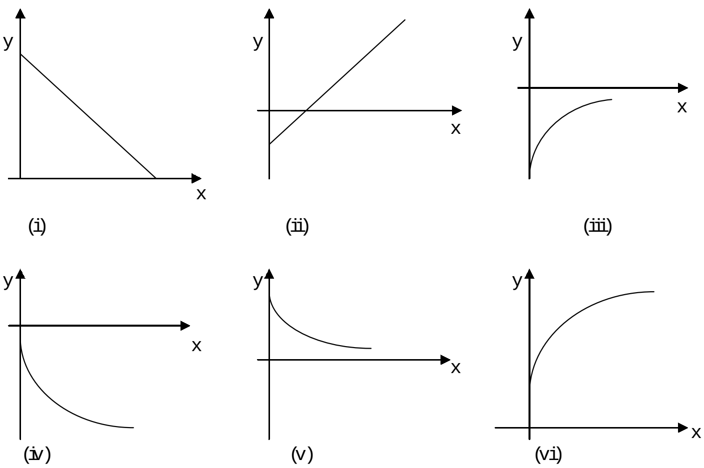


Figure 4

A number of questions involving graph transformations were included, of which the following two are typical examples.

4. Draw the appropriate *s-t* graph on the given axes to match the given *v-t* graph and state reasons for the shape of your graph:

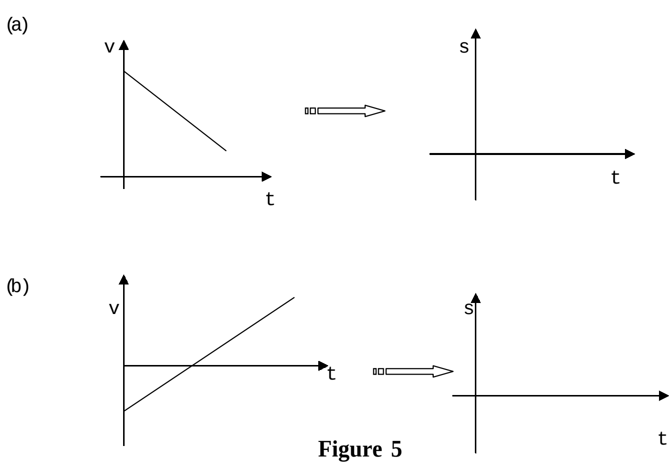


Figure 5

RESEARCH RESULTS AND DISCUSSION

The results of the investigation showed that although the majority of the respondents had little difficulty in explaining the idea of *displacement* in their own words, they experienced particular difficulty with *velocity* and *acceleration*. Fewer than 50% of the students questioned, could explain the latter two concepts in their own words. The main reason for this seems to be a poor comprehension of the *rate of change* concept. For example, in trying to give their own version of the meaning of acceleration as the *time-rate of change of velocity*, altogether 27% of the students did not manage to give a coherent explanation when attempting to explain this in terms of "rate of change". Many answers were confusing or even totally incoherent. Examples of the latter include:

Acceleration is the rate of change of velocity divided by the rate of change of time or… *acceleration is the rate at which speed is measured.*

A cause for concern is the fact that approximately 19% of the respondents had no idea whatsoever about the meaning of acceleration as illustrated by responses such as: it *is the time for a body to move from point A to point B.*

With reference to question 2, students were seldom able to give more than a very simplistic explanation of the gradient concept. In spite of the fact that the question was rather open-ended, it was clear that students were extremely reluctant to mention the gradient of tangents to curved s-t graphs as an indication of instantaneous velocity. Similarly, *negative* gradients of *s-t* graphs were often not linked to negative *velocities*. Only 3% of the respondents mentioned the fact that the gradient of *a-t* graphs represent the rate of change of acceleration. This very low percentage is significant, in view of the fact that this is an idea that is seldom formally encountered in traditional kinematics syllabi. It meant that the test group had to rely on their own intuitive comprehension of the meaning of gradient in *a-t* graphs.

The most disturbing finding however was that only 12% of the respondents chose to explain gradients of *s-t* and *v-t* graphs in terms of rate of change of *displacement* and *velocity* respectively.

In order to further investigate students' comprehension of acceleration in the context of an arbitrary sign convention and its resulting relation to velocity, the test group were asked to consider the sign of the acceleration vector by observing a fictitious motion. The results are indicated in table 1.

Nature of motion	Correct sign of the acceleration vector	% correct replies
Slowing down while traveling in a positive direction	Negative	58%
Speeding up while traveling in a negative direction.	Negative	29%
Slowing down while traveling in a negative direction	Positive	32%

Table 1. **Distribution of answers to sign of acceleration vector**

The results indicate that the test group experienced serious difficulty when negative kinematic quantities were being considered. When asked to give a brief reason for their responses, very few (approximately 5%) of the respondents indicated that they made use of the gradient of the *v-t* graph to arrive at their answers. These students arrived at the correct answer by simply observing (for the third case above) that the acceleration has to be positive because the *v-t* graph has a constant positive gradient. (See figure 6).

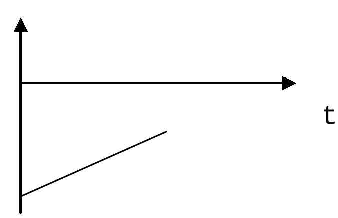


Figure 6

Question 3 served the purpose of investigating whether learners understood the meaning of negative gradient and to what extent they could recognise graphs with negative gradient when confronted with a number of graphical representations on the Cartesian plane. Only 35% of the respondents were able to correctly identify graphs (i), (iv) and (v) as having negative gradients, while as many as one-third of the students included graph (iii) in their list of negative gradients. This seems to indicate that these students confuse the sign of the *gradient* with the sign of the *ordinate* values. The reason for the poor response could be due to one or both of the following two factors:

- some graphs were curved, which meant that the gradient was changing. This might have made the identification of a *negative* (but *increasing* or *decreasing*) gradient more problematic than would have been the case for normal straight line graphs;
- a number of graphs were drawn at least partially below the time axis, which meant that students were required to focus purely on the *direction*

of the graph and ignore the fact that it was drawn for negative values.

A further confirmation of the hypothesis that respondents tended to focus on the sign of the ordinate is that a further 20% opted for the combination (ii), (iii) and (iv), which are the *only* graphs with negative values for the dependent variable (y).

Graphs (iii) and (vi) are the only ones with a *decreasing positive* gradient. Some students combined these two graphs with (i) (which they accepted must have a negative gradient). This seems to indicate that for these students (5% of the respondents) a function for which the rate of increase *decreases* should also have a *negative* gradient. In other words they seem to have made the association: decreasing gradient à negative gradient.

The questions involving graph-graph transformations were included because they could readily be performed in terms of gradient considerations. In the case of question 4(a) for example, students simply had to note the given decreasing but positive ordinates of the

v-t graph and translate this into an *s-t* curve for which the gradient of the tangent was also decreasing but positive. The analysis of the questionnaire reveals that, on average approximately 8% of the respondents explained this correct graph à graph transformation in terms of gradients or change in gradients. Table 2 illustrates how the proportion of students who managed to perform correct *v-t* à *s-t* transformations, decreases as the given *v-t* graph becomes increasingly complex. The given *v-t* graph initially indicates a constant velocity, then an increasing positive velocity, a decreasing positive velocity and finally an increasing velocity starting with a negative value.

Gradients were rarely used to explain transformations, however when used it usually resulted in correctly shaped graphs. As an illustration, transformation no. 4 of table 2 is relatively easy to achieve by observing that the required graph has to start with a negative gradient which decreases in magnitude to zero, after which it increases positively in accordance with the ordinates of the given *v-t* graph. Only 7 students from the test group used this type of argument (i.e. involving changing gradients) and **all** of these students drew correct s-t graphs. This lends further weight to the hypothesis that a focus on slope usually clarifies the nature of the physical situation which is under consideration as well as simplifying graph transformation tasks.

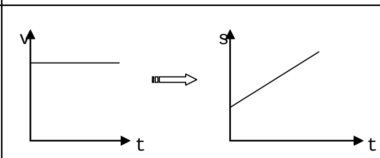
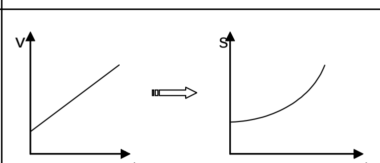
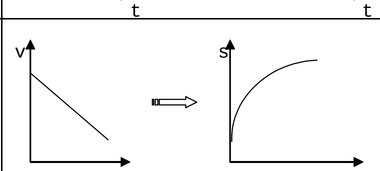
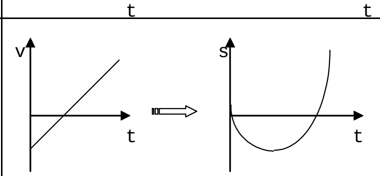
No	v-t s-t transformation	% Correct graphs	% Candidates successfully using gradient
1		79%	7%
2		43%	6%
3		33%	5%
4		11%	2%

Table 2
Proportion of students using gradients to explain graph transformations

Further evidence for the fact that the failure to use gradients can seriously impede the graph transformation ability of students is found in the response to a question that asked whether the transformation indicated in figure 7 is valid. Of the 31% who agreed that the *s-t* graph does indeed represent the same motion as the *v-t* graph, only 5% attributed this to the fact that the *s-t* graph had a *constant negative gradient* to accompany the *constant negative ordinates* of the given *v-t* graph. In fact, 8% of the candidates simply stated that the *s-t* graph is *also a negative graph*!

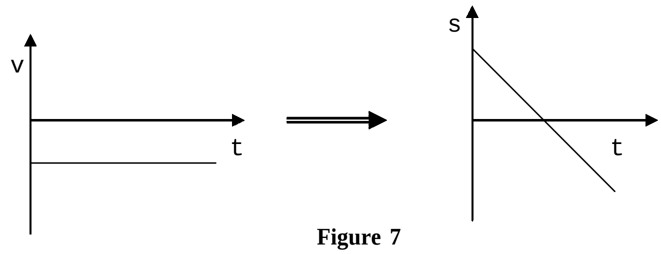


Figure 7

The relatively simpler *s-t* à *v-t* transformation of figure 8 require students to notice the constant positive gradient and translate this into a positive straight line parallel to the t-axis.

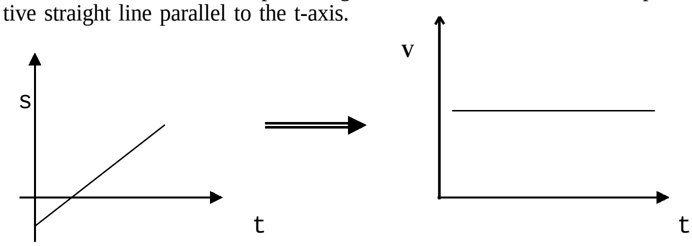


Figure 8

Of the 26% who achieved this, a mere 27% stated that they used the method involving gradients i.e. that the observed constant gradient of the s-t graph gives rise to a constant positive v-t graph.

An analysis of the results of the empirical study reveals that, with respect to transformation no 4 of table 2, 17% of all respondents who proved their ability to differentiate between negative and positive gradients, were successful at drawing the correct *s-t* graph. This represents a moderate improvement on the general success rate of 11%. However, when ability to recognise negative gradient is correlated with the recognition of the validity of the transformation illustrated by figure 7, no improvement is found. This seems to indicate that the poor transformation skills exhibited by students with regard to figure 7 as well as transformation number 4 of table 2 cannot solely be attributed to a failure to recognise the difference between positive and negative gradients.

When knowledge and understanding of the role of gradients of tangents to *curved* graphs is cross-tabulated with success rate at achieving the transformations of table 2 resulting in *curved graphs*, a significant improvement is noted. This is shown in table 3.

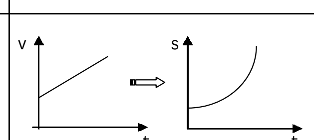
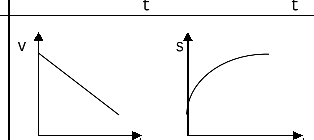
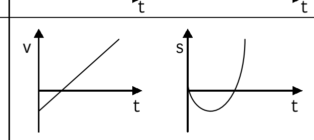
No	v-t s-t transformation	Overall success rate	Success rate for candidates with proven understanding of gradient of tangents
2		43%	83%
3		33%	67%
4		11%	18%

Table 3
Comparison of successful graph transformations: all respondents vs. those with understanding of gradient of tangents

This indicates that many students learners struggle with *v-t* à *s-t* conversions because they fail to think of their *s-t* graphs as curves of tangents with *continuously changing gradients, to match the continuously changing height of the given v-t graph.*

The success rate for no. 4 remains low however, possibly because many students when thinking in terms of changing gradients still experience difficulty with the idea of *a decreasing magnitude of a negative gradient*. The poor response to the task involving "slowing down while traveling in a negative direction" (see table 1) can probably also be attributed to this.

Interviews with a number of students revealed large discrepancies in the level of their comprehension of the role that slope plays in graph transformations. A significant proportion (20%) merely mimicked or copied the given graph when asked about the shape of the required *v-t* graph in the transformation illustrated in figure 9.

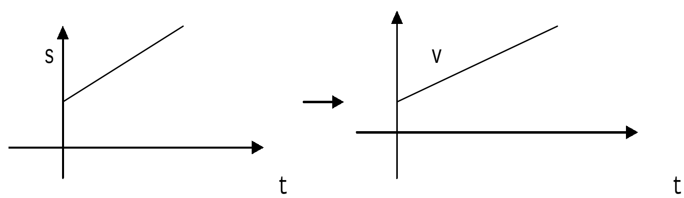


Figure 9. Mimicked s-t à v-t transformation

In view of their reluctance (or inability) to use gradients and therefore translate the observed constant slope into a constant velocity, these students typically declared: *the velocity increases at a constant rate because the displacement increases at a constant rate.* In contrast to this a limited number of students demonstrated an excellent grasp of the concept of changing gradients. One student verbalized the fact that the turning point of the *s-t* graph occurs at the intercept of the *v-t* graph with the time axis. This student declared (with reference to transformation no. 4): *the gradient at the turning point must be naught, so the speed must be naught here as well, so this is where we are on the v-t graph* (points to intercept of *v-t* graph with time axis).

CONCLUSIONS

The use of gradient as an indicator of rate of change is fundamental to both the analysis as well as the construction of graphs in many academic disciplines. In spite of this importance, it is an idea that is rarely used and/or understood by the students that we teach.

This study shows that this reluctance to focus on gradients is particularly true in kinematics. Graphs, and especially the ability to construct a different kinematic graph from one that is given, is crucial for a proper understanding of the motion that is being considered. By merely considering that the **slope** of the s-t graph yields **velocity** and the **slope** of the v-t graph yields **acceleration**, both graph interpretation as well as construction tasks are easily carried out.

The present study reveals that students experience particular difficulty with the following ideas:

- The association of a larger magnitude of gradient with a bigger rate of change;
- the fact that the gradient of the tangent to a curved graph gives the instantaneous rate of change at that point;
- the distinction between negative and positive gradients;
- the gradients of graphs that depict *negative* values of the quantity that is being investigated;
- The use of the gradient concept to properly interpret various kinematic graphs.

An important challenge for science and mathematics educators is to actively promote the use of gradient as an indicator of rate of change in their teaching. This will give students an additional (and powerful!) tool for interpreting and constructing graphs, not only in physics and mathematics, but in all walks of life.

RECOMMENDATIONS

To address the problems experienced by students, the following approach can be considered. Although we have not formally researched the approach when teaching graphs, we often make use of a technique described by Liew & Treagust (1995: 68-71) as the *Predict-Observe-Explain* (POE) technique. The basic approach is to require students, working in small groups, to **predict** the shape of a *velocity-time* graph when they are given a *position-time* graph such as the ones in fig. 1 and fig. 8 (or the converse, to predict the shape of a *position-time* graph when they are given a *velocity -time* graph such as the ones in fig. 7 and table. 3. After they have reached consensus, the teacher supplies the correct answer which accounts for the **observe** phase. The students must compare their answers to the correct answer and if there are discrepancies, they must try to resolve these for themselves in their small groups. If they then still do not understand, the teacher can intervene and explain.

If the students have access to a microcomputer based laboratory (MBL), a similar procedure can be followed. [An MBL is a self-contained laboratory pack consisting of a microcomputer, software, sensor equipment, a digital interface for collecting data and other apparatus.] The basic approach is to require learners, working in small groups, to **predict** what would happen during the execution of a specific experiment, or what effect would be observed if specific changes are made to an experimental set-up or what they should do to obtain a specific result for a given experimental set-up. The experiment / demonstration is then conducted. They must then **observe** what happens and if their predictions differ from the experimental result, they must try to **explain** any discrepancies between the predicted and observed results. The following example of simplified projectile motion serves as a typical exemplar.

In this activity, participants receive a detailed worksheet in which they are instructed to prepare the experimental set-up shown in figure 10. The computer is pre-programmed so that the reference point is at the sensor (motion detector) and the direction **up** the incline is taken as **positive**.

They are then required to **predict** in small groups the shapes of the x-t, v-t and a-t graphs for a ball rolling up and down the incline using the stated frame of reference. The participants must then do the investigation and are instructed to repeat the experiment until a smooth graph is obtained. Before they continue with the structured section of the worksheet, they must **observe** and try to **explain** any discrepancies between their predicted and the observed graphs. If they then still do not understand, the teacher can intervene and explain. Green (2004:256) reports varying success while using this method, but more work is required before any definite conclusions can be drawn.

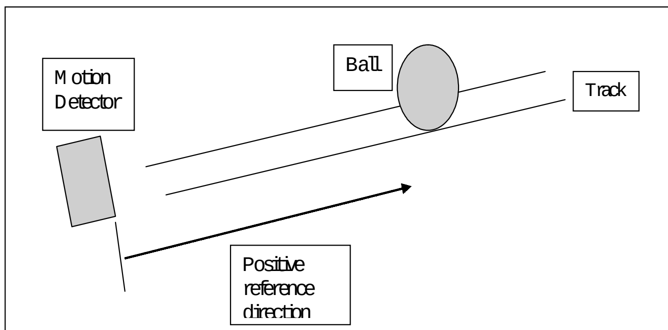


Figure 10: Set-up to investigate the different ways in which a ball rolling up and down an incline can be represented graphically and the relationship between these graphical representations.

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An investigation into the Greek secondary school graduates' knowledge and awareness of healthy diet and nutrition

Una investigación sobre el conocimiento y conciencia en dietas sanas y nutrición de los estudiantes griegos de enseñanza media

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Abstract

The aim of this study was to assess Greek secondary school graduates' knowledge of healthy diet, and the factors that could affect it. Our results show that, to a large extend, students know what healthy food is. They lack however satisfactory knowledge on the chemical constitution of foods. Although family plays a major role in influencing their dietary habits, their main information source, on dietary matters, is television, with school to a lesser extend. Finally students believe that school could extend its influence in the shaping of their dietary patterns through suitable educational programmes.

Key words: *diet, students, health, school*

Resumen

El objetivo de este estudio es evaluar el conocimiento que tienen los estudiantes griegos graduados de enseñanza media sobre dietas sanas y los factores que pueden afectarlas. Los resultados muestran que, en general, los estudiantes saben lo que es comida sana. Sin embargo, no poseen un conocimiento satisfactorio sobre la constitución química de los alimentos. Aunque la familia juega un papel primordial e influencia sus costumbres alimenticias, las fuente más importantes de información sobre materias dietéticas son la televisión y, con menos relevancia, la escuela. Finalmente, los estudiantes creen que la escuela podría influir más y afectar sus costumbres dietéticas a través de programas educacionales adecuados.

Palabras clave: *dieta, estudiantes, salud, escuela.*

INTRODUCTION

Diet is a major factor of importance for public health. Researchers agree that a relationship exists between diet and chronic disease, but converting the research into changes in dietary behaviour poses a challenge (National Research Council, 1999; Healthy People, 2000). Originating in childhood and influenced by cultural background, eating habits remain resistant to change without long-term commitment (GRITZ and BASTANI, 1993).

Several factors influence eating habits. Children's and young adults' food preferences resemble their parents' (PLINER and PELCHAT, 1986; ROZIN *et. al.*, 1984). The probability of engaging in health-risk behaviours is less influenced by parental presence and authoritative parenting practices (FORS *et. al.*, 1999; JACKSON *et. al.*, 1994). However, limited evidence demonstrates the influence of parents on specific eating behaviors other than as a role model (WOODWARD *et. al.*, 1996), physical monitoring of intake (HILL *et. al.*, 1998), providing the food, or giving nutrition advice (HILL *et. al.*, 1998). Due to the important relationship between diet and health, avenues to effectively facilitate consumption of healthy foods are essential.

NEUMARK-SZTAINER *et. al.*, (1996) have demonstrated a strong association between fruit and vegetable intake and family connectedness. YOUNG and FORS, (2001) confirm these findings and add important factors such as hours spent at home without an adult and the parental situation of the adolescent. They also found that as the grade increases so does the percent of students who do not eat healthy foods as they get older.

MURPHY *et. al.*, (1994) found that students are interested in learning about nutrition with a personal effect on their own health and well being. Their interests varied somehow by grade, but topics of weight control, nutrition and disease, and how to improve their diet were of particular interest across all grades. They also found that across grade levels student's preferred active rather than passive methods of learning about nutrition. Teachers therefore need to find ways to allow students to be active participants in nutrition instruction, and to provide opportunities for students to apply learning through doing. Finally it was found that students prefer to learn through interdisciplinary or team teaching. KEIRLE and THOMAS (2000) confirm these findings with their investigation where they conclude that comprehensive health education programmes contribute significantly to the students' knowledge and behaviour to diet. However, other personal and socioeconomical factors could also influence students' knowledge and behavior to eating habits.

In the present study we assessed the dietary habits of Greek secondary school graduates (of both sexes) and the factors that might influence them.

METHODOLOGY APPLIED IN THE INVESTIGATION

Subjects

In the study participated 346 Greek secondary school graduates (172 boys and 174 girls) who gained entrance into the first year of University.

Methodology

A questionnaire consisting of 12 questions was constructed for the specific needs of the present study (Appendix I). The questionnaire required the students to indicate what they eat, what is a healthy diet, their knowledge of the chemical constitution of different kinds of food, how and where from they gained knowledge about the different foods etc.

Our data were statistically analyzed using x^2. For all statistical analyses, a level of at least 0.05 was used to determine significance.

RESULTS AND DISCUSSION

1. Results

Actual dietary habits of students

1) To the first question *how often do you consume the foods of the following list*, for <u>every day</u> 51.6% answered they eat yoghurt and milk, 49.4% olive oil, 49.1% bread, 48% cheese and butter, 32.5% fruits, 29.8% vegetables, 27% sweets; for <u>twice or three times a week</u> 52.3% answered potatoes, 52.1% pasta, 43.3% eggs and chicken, 39.8% sweets, 37.6%