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AUTHOR	Ramirez, Rene; Flores, Homero
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ABSTRACT

This paper takes G.K. Chesterton's short story, "The Three Horsemen of Apocalypse," as a motivating introduction to the study of linear equations systems, as well as a review of the concept of linear function. The guide has three objectives: (1) to illustrate how to use non-mathematical sources to create math problems; (2) to use the graphing calculator (TI-92) to go from one representation of the problem to another; and (3) to suggest an activity which reviews the linear function and systems of linear equations. (Author/ASK)

CHESTERTON AND MATHEMATICS: THE THREE RIDERS OF APOCALYPSE (Introduction to systems of linear equations, workshop)

René Ramírez
Homero Flores
Colegio de Ciencias y Humanidades
Universidad Nacional Autónoma de México
ahfs@servidor.unam.mx

ABSTRACT

We take G. K. Chesterton's short story, *The three horsemen of apocalypse*, as a motivating introduction to the study of linear equations systems, as well as a review of the concept of linear function.

INTRODUCTION

In the early seventies, the Colegio de Ciencias y Humanidades (CCH) was created at the Universidad Nacional Autónoma de México (UNAM). It constituted a very ambitious project involving the three highest levels of education in Mexico, namely: *Bachillerato* (grades K10, K11, and K12 in the USA), *Licenciatura* (university or college level), and *Posgrado* (postgraduate and upper levels). The main purpose of the brand new institution was to create citizens with a sound integral education, prepared to face all the challenges that may encounter in their academic or professional lives. Individuals

who would be able to criticize the political, economic, and social environment of our Country and could suggest solutions and make decisions. The three basic goals were:

- Learn to learn
- Learn to do
- Learn to be

The CCH Project never saw a completion. Today, only the lower level persists as an educational subsystem at the UNAM. Nevertheless, the CCH has been successful at the high school level. It consists of five campuses, about twenty thousand students each, spread along the urban area of Mexico City. Many private and public schools at the bachillerato level throughout the country had adopted the CCH curriculum. We, as teachers and members of the academic community of the CCH, are convinced that our three basic goals are still valid, and we are involved in an every day struggle to fulfill them.

Therefore, in the context already described, we believe that the teaching of mathematics is more effective if we approach it from a problem-solving environment in which we can use the new educational technology (like the personal computer and the graphic calculator). Although the generalized use of technology is far from being a reality in our schools, there is a growing trend to that direction.

OBJECTIVES

The present workshop has several objectives:

- To illustrate how can we use non-mathematical sources to create an atmosphere of problem solving.

- To use the graphic calculator (The TI-92 in this case) to go from one representation of the problem to another.
- To suggest an activity that can be useful in making a review of the linear function, in order to introduce the systems of linear equations

POSING THE PROBLEM

Our story begins with a war and a paradox. We are talking about the Prussian occupation in Poland and the anecdote tall by G. K. Chesterton about a Polish poet, a Marshal and a Prince. The story, *The Three Horsemen of Apocalypse,* appeared in *The Mr. Pond Paradoxes*, written in 1932. Let's see what Chesterton said through Mr. Pond's words:

> *"I expect you remember hearing", said Pond, "of all the excitement there was about Paul Petrowski, the poet from Cracow, who did two things rather dangerous in those days: moving from Cracow and going to live in Poznan; and trying to combine being a poet with being a patriot. The town he was living in was held at the moment by the Prussians; it was situated exactly at the eastern end of the long causeway; the Prussian command having naturally taken care to hold the bridgehead on such a solitary bridge across such a sea of swamps. But their base for that particular operation was the western end of the causeway; the celebrated Marshal Von Grock was in general command; and, as it happened, his own old regiment, which was still his favorite regiment, the White Hussars, was posted nearest to the beginning of the great embanked road...The whole thing*

went wrong because the discipline was too good. Grock's soldiers obeyed him too well; so he simply couldn't do a thing he wanted."

Anyway, the thing is that the poet Petrowski was caught in Poznan, the military authorities didn't know what to do with the prisoner and were going to set him free, unless they had opposite orders from the superior authorities. Von Grock was determined for the poet's death; he sent orders for his immediate execution. A few minutes later, a reprieve was sent to save the poet. The rider carrying the pardon died in the way to Poznan, and, after all, the prisoner was released. How this came to happen? Here, it seems, there is a contradiction.

At this part of our story may raise the question: what on earth does all this stuff about Hussars, poets and Marshals have to do with mathematical linear functions and systems?

Let's go further. Right after Marshal Von Grock had sent his messenger, the Prince came to camp. Here it is what they said to each other:

"To talk of executing a man like that is madness", said the Prince, scowling under his black helmet. "He is not a common Pole. He is an European institution. He would be deplored and deified by our allies, by our friends, even by our fellow-Germans. Do you want to be the mad women who murdered Orpheus?"

"Highness", said the Marshal, "he would be deplored; but he would be dead. He would be deified; but he would be dead. Whatever he means to do, he would never do it. Whatever he is doing, he would do no more. Death is the fact of all the facts; and I am rather fond of facts."

"Do you know nothing of the world?" demanded the Prince.

"I care nothing for the world", answered Grock, "beyond the last black and white post of the Fatherland."

"God in heaven," cried His Highness, "you would have hanged Goethe for a quarrel with Weimar!"

"For the safety of your Royal House," answered Grock, "without one instant's hesitation."

There was a short silence and the Prince said sharply and suddenly: "What does this mean?"

"It means that I had not an instant's hesitation," replied the Marshal steadily. "I have already myself sent orders for the execution of Petrowski."

So, His Highness the Prince immediately sent the swiftest horseman in camp with a reprieve written by his own hand. This second rider went on his way about fifteen minutes after de first one. He had orders to stop the first rider and to deliver the reprieve to the military authorities. But, as I said before, Marshal Von Grock was determined to kill Petrowski, so, right after the Prince left, he sent a third horseman. This time the orders were not to stop the second rider, but to shoot him as soon as he was at shooting distance. The order was accomplished some time later:

"...The truth was that the straight road before him was not only dreary, but seem interminable long. He would never have believed he could have ridden so far without catching some distant glimpse of the man he followed. Von Schacht (the second rider) *must indeed have the fleetest of horses to have got so far ahead already;*

for, after all, he have only started, at whatever speed, within a comparatively short time...he hardly expected to overtake him; but a very realistic sense of the distances involved had told him that he must very soon come in sight of him. And then, just as despair was beginning to descend and spread itself vaguely over the desolate landscape, he saw him at last.

...He unslung his carbine; and a shock of unnatural noise shook up all the wild fowl for miles upon the silent marshes. But Sergeant Schwartz (the third rider) *did not trouble about them. What interested him was that, even at such a distance, he could see the straight, white figure turn crooked and alter in shape, as if the man had suddenly grown deformed. He was hanging like a humpback over the saddle; and Schwartz, with his exact eye and long experience, was certain that his victim was shot through the body; and almost certain that he was shot through the heart. Then he brought the horse down with a second shot; and the whole equestrian group heeled over and slipped and slid and vanished in one white flash into the dark fenland below.*

Thus, this third rider got back to camp. Some time later he and Marshal Von Grock were standing on the same place where the rider was killed. Von Glock sent his horseman to Poznan to testify the execution. Schwarz went to town only to see Petrowski walk free out of prison: the military authorities in Poznan didn't receive any order.

The reason why no messenger came to Poznan had to do with the excess of discipline we mentioned before. When the first rider

heard the shouting to stop, he did; but, thinking that the other was the carrier of the reprieve, waited him with his gun ready to shoot. So, he killed the Prince's messenger in name of his loyalty to the Marshal.

> *"Then he returned again and rode on, carrying the death warrant of the Pole. Behind him horse and man had crashed over the edge of the embankment, so that the whole road was clear. And along that clear and open road toiled in his turn the third messenger, marveling at the interminable length of his journey; till he saw at last the unmistakable uniform of a hussar like a white star disappearing in the distance, and he shot also. Only not to kill the second messenger, but the first.*
>
> *"That was why"*, ended the story Mr. Pond, *"no messenger came alive to the Polish town that night. That was why the prisoner walked out of his prison alive. Do you think I was quite wrong in saying that Von Grock had two faithful servants, and one too many?"*

THE MATHEMATICS

Activity one

Suppose that the first rider (R_1) does the whole trip to Poznan (100 km) with a speed of 30 km/hr.

1. Build a table in your graphic calculator in which you have the time elapsed in the first column and the distance traveled in the second. (You must choose the proper units to work with.) How much time does it takes for the rider to get to Poznan? From the analysis of the values in the table, can

you say if the relation between time and distance is a linear function? Why?

2. From the table, build a time vs. distance plot. That plot confirms the answer in point 1? Why?
3. From the table, find an algebraic relationship between time and distance.
4. Use the calculator to prove that the relationship found is the algebraic representation of the curve built in point 2.
5. What are the domain and range for this particular function? Explain.
6. Is there a proportional variation between time and distance? Explain.

Activity 2

Suppose that the first rider (R_1) travels at 27 km/h, the second (R_2) at 39 km/h, and the third (R_3) at 35 km/h.

1. In your calculator, build a table in which the time is in the first column, the distance traveled by the first rider is on the second one, the distance traveled by the second rider is in the third one, and the distance traveled by the third rider is on the fourth one. Suppose that the second rider never shouts at the second one, simply he comes to meet him. From the table found the time and distance in which the second rider meets the first one.
2. Build R_1's distance vs. time plot, and R_2's distance vs. time plots. From this graph can you determine the exact intersection point of the two lines? Why?

3. Is there proportional variation in the relationship between time and distance in both motions? Explain.

4. Actually, the third rider killed the first one. From the table, determine the time elapsed between the moment in which the first rider kills the second one, and the instant in which the third rider is 300 m behind the first one.

5. The distance-time relationships of the riders' motion are linear functions. Determine domain, range, and correspondence rule of each function.

6. Using the correspondence rules of the functions in point 5, determine the time and distance of the second rider meeting the first one, and the time and distance the third rider shooting the first one.

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Signature:	Printed Name/Position/Title: Homero Flores.	
Organization/Address: Colegio de Ciencias y Humanidades. UNAM-México	Telephone: (52) 56-22-23-82	FAX:
	E-Mail Address: ahfs@servidor.unam.mx	Date: 03/26/01