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HIGH SCHOOL STUDENTS' CONCEPTUAL UNDERSTANDING OF PARABOLIC MOTION

TRUDEL, LOUIS
FACULTY OF EDUCATION
UNIVERSITY OF OTTAWA
CANADA
METIOUI, ABDELJALIL
DEPARTEMENT DE DIDACTIQUE
UNIVERSITE DU QUEBEC A MONTREAL
CANADA

Prof. Louis Trudel
Faculty of Education
University of Ottawa
Canada.

Prof. Abdeljalil Métioui
Département de Didactique
Université du Québec à Montréal
Canada.

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Synopsis:

High school students experience difficulties when they studied parabolic motion since it requires, to understand its properties, that they combine one dimensional kinematics concepts. To understand the nature of their difficulties, we analyzed with qualitative methods the content of students' answers to a questionnaire. Among key results, we found that many students encounter difficulties differentiating between position (time) and speed (time) along X and Y components.

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Louis Trudel [a] & Abdeljalil Métioui[b]
[a] Université d'Ottawa (Canada) , [b]Université du Québec à Montréal (Canada)

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Due to the complex nature of motion, high school students experience difficulty to construct strong conceptual understanding of the important differences between key principles of kinematics: position, velocity, acceleration, and time in one dimension (Knight, 2004). Moreover, students harbour many misconceptions when it comes to graphical interpretation and representation. For them, graphs are seen as literal pictures of the situation and not as indicators of which type of motion is occurring. Students may also confuse the meaning of the slope of a line and the height of a point of the line (Beichner, 1994). As such, it requires a great deal of conceptual understanding to correctly interpret the graphical representation of an object's position relative to time and translate that understanding to the correct representation of the object's velocity relative to time as well as its acceleration relative to time graphs. These difficulties are compounded when they studied parabolic motion since it requires the understanding of the various motion concepts used in one dimensional kinematics and, on the top of that, how to combine them to understand properties of parabolic motion (Dilbert, Karaman & Duzgun, 2009). Our research objective is thus to study students' difficulties in understanding the properties of objects undergoing parabolic motion using Cartesian graphs.

As such, instead of analysing answers of students to paper and pencil problems to parabolic motion, this research is trying to uncover their patterns of thought while trying to predict the properties of parabolic motion of objects presented in concrete set-ups. This research is thus in continuity with precedent ones about conceptual difficulties encountered by students to translate the results of experiments in graphs (Borghi, De Ambrosis, Lamberti & Mascheretti, 2005). The concrete set-up of the first case consists of one ball rolling at constant speed while, at the same time, the other one undergoes a parabolic motion. In the second case, the concrete set-up consists of one ball going down in free fall while, at the same time, the other ball undergoes parabolic motion. A student's guide was distributed to each student which contained the questions to be answered about each case as well as the Cartesian graphs to be completed. After the teacher explained to his students each case, but without actually doing the experiment, he asked them to draw individually their predictions about the shape they think the curves of position-time and speed-time of the balls would be in Cartesian graphs along X and Y coordinates.

To study the learning difficulties of students, we analyzed the content of the answers of the students in the guide. These traces written by students were expressed in various ways: verbal, iconic and graphics. From the perspective of social semiotics, information from these different sources can be combined to form metaphors to make sense (Mavers & Kress, 2005).

Regarding the qualitative data collected in this research, we followed the method developed by Miles, Huberman and Saldaña (2014) to classify data into pre-established categories or create new categories.

Our study consisted of two groups of 21 and 24 French-speaking pupils respectively, attending a physics course in a high school of the province of Ontario in Canada. The first group was composed mainly of students who had chosen a special orientation toward science offered by the school so that it is reasonable to assume that they were interested by science in general and physics in particular. The second group was composed of regular students and a small number of students with learning disabilities. The teacher of the first group was of feminine gender and had five years of experience in science teaching. The teacher of the second group was of masculine gender and had twenty years of experience in teaching science and mathematics. Both teachers held bachelor degree in science and a teaching certificate in science teaching.

Among key results, we found that many students encounter difficulties differentiating between position (time) and speed (time) along X and Y components, drawing similar graphs for both. Many students had also difficulties identifying which type of motion (i.e. constant speed motion or uniformly accelerated motion) corresponded to each ball and drawing the proper curve in the corresponding Cartesian graph. Finally, we discuss advantages and limits of this research and make suggestions for subsequent research.

References:

Beichner, R. J. (1994). Testing student interpretation of kinematics graphs. *American Journal of Physics , 62 (8),* 750-762.

Borghi, L., De Ambrosis, A., Mascheretti, N. & Lamberti, P. (2005). A teaching-learning sequence on free fall motion. *Physics Education*, 40(3), 266-273

Dilbert, R., Karaman, I., & Duzgun, B. (2009). High school students' understanding of projectile motion concepts. *Educational Research and Evaluation, 15(3),* 203–222.

Knight, R. D. (2004). *Five Easy Lessons: Strategies for Successful Physics Teaching.* San Francisco (CA): Addison Wesley.

Kress, G., & Mavers, P. (2004). Social semiotics and multimodal texts. In Lewin, C., & Somekh, B. (Eds), *Research Methods in the Social Sciences*, pp. 172-179. London (GBR): Sage Publications.

Miles, M.B., Huberman, A.M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook.* Washington (DC): SAGE, 2014.