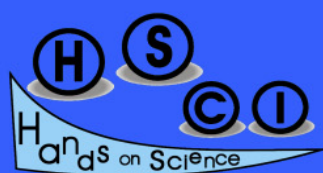


# Hands-on Science

## Brightening our Future

Edited by  
Manuel Filipe P. C. Martins Costa  
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The Hands-on Science Network



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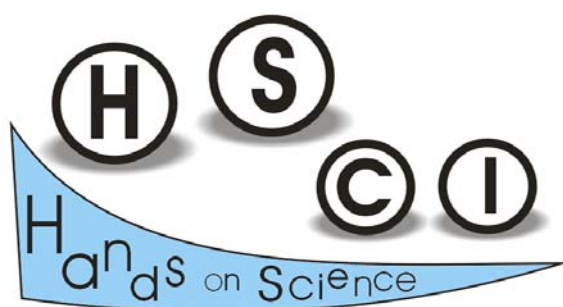


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## Learning to Be Critical with Mathematics: Body Mass Index

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**Abstract.** This paper presents part of an investigation from the first author's master, whose aim was to discuss how Critical Mathematics Education in school contributes to the formation of critical and responsible citizens. The empirical basis of this study consisted in the implementation of a learning scenario which purpose was to work with students the critical analysis of some news in newspapers and magazines, whose topics were focused on Body Mass Index. Given the stated purpose of the study, we choose a qualitative research methodology with interpretative nature.

**Keywords.** Critical Mathematics Education, Critical Citizens.

### 1. Introduction

The school should provide a social environment where students learn to live in society, by living. The responsibility of educating for citizenship should not be just a task of a specific school discipline, but from all those who are part of the school community [1].

If we want to promote and enrich the development of critical thinking in our students, therefore we must not explore problems based on 'realities of make-believe' that are illustrating mathematics as the science of hypothetical situations. But instead, if we choose real situations, connected with students' daily life and related with students' background and foreground, we will be certainly allowing their engagement during classes [2].

Therefore, it is necessary to make time for dialogue in the classroom, sharing opinions and discussing the topics presented in class. Only this way we will be able to avoid the students to become passive and indifferent, even the most curious, accepting all the information they are presented everyday without questioning.

We believe the students will only and truly understand how the mathematical models that explain politics, economics, science and others work, if instead of adjusting real situations to the mathematical contents, we start by analysing those situations and from that analysis identify which mathematical contents support them.

The learning scenario was created to be implemented with an 8<sup>th</sup> grade class, from a school in the suburbs of Funchal. 'Extreme thinness' was the theme of the learning scenario and it was prepared based on a magazine article, describing the low weight of some celebrities. The analysis of the magazine article encouraged students to explore the concept of Body Mass Index (BMI). In attempting to understand what relationship existed between height and weight to calculate BMI, students had a first contact with the literal equations. This mathematical content appears in a natural way, where the variables have a specific meaning, that is, not only a set of 'alphabet letters' and symbols related to each other.

The focus of this approach was not restricted to BMI calculation. Through the questions asked to students, we also tried to address diseases related with eating disorders that manifest themselves with some frequency on teenagers. We also end out discussing with students the power of media and how it affects students' opinions on various subjects.

### 2. Learning through Critical Mathematics Education

"Certain qualities of communication, which we try to express in terms of dialogue, support certain qualities in learning of mathematics, which we refer to as critical learning of mathematics manifested by the competence of mathemacy" ([3], p. 10).

This learning approach for mathematics is based on communication and discusses that communication qualities are learning qualities. The student/teacher relationship influences the dialogue and, therefore, the learning process of the students. In this perspective, communicating comprises a deeper meaning than the common sense [3]. The learning process occurs in social contexts of interpersonal relationships. The quality of communication affects the learning of those

involved in the process. And the communication is directly related with the dialogue [3].

The student/teacher relationship might influence the dialogue and therefore the learning process of the students. According to Freire in Alro and Skovsmose [3], “dialogue is fundamental for freedom to learn. [...] He defines dialogue as a meeting between people in order to ‘name to the world’” (p. 3).

We will contribute for the students’ engagement during the activities developed in class through dialogue and the choice of tasks that are interesting to the students, adequate for their age, social context, related to their ‘background’ (according to Skovsmose [4], it consists in a relationship network and socially built meanings, which belong to the history of each individual) and ‘foreground’ (according to Skovsmose [4], it consists in a group of expectations created by social situations that are introduced to the individual as possibilities). This way the students will be more awake to analyse and identify daily situations where mathematics is used abusively and in a misleading manner, with the intent of manipulating information and deceive the less attentive, or when it appears hidden and using more complex mathematic models.

By critically approaching the Mathematics Education, we are contributing to the development of ‘mathemacy’, which according to Alro and Skovsmose it is “more than an understanding of numbers and figures, also more than an ability to apply numbers and figures to a variety of situations” ([3], p.136).

In the Critical Mathematics Education, the education is focused on people and it “(...) prepares the students for democracy, whereas the traditional mode socializes the students to obey power and control” (Rogers in Alro and Skovsmose ([3], p. 4).

### **3. Methodology**

The present investigation assumes a qualitative nature with an interpretative character, and its main purpose is to better understand the behaviour and the human experience, as Bogdan and Biklen [5] mentioned.

This type of methodology assumes a

naturalistic and descriptive nature about the empirical observation of the students’ behaviour, in light of specific situations, namely during tasks that involve critical thinking.

The data collection was conducted in an 8<sup>th</sup> grade class in a school located in the suburbs of Funchal.

In terms of the methodology used, direct observation should be highlighted. It played a very important role, as it allowed understanding in which way the students face the proposed situations and tasks and what is their opinion on the issues discussed in them.

In this sense, the teacher walked through the classroom and dialogued with the students, while informally registered the most relevant comments and observations. The students were quite honest and spontaneous in their interventions, as the investigator is the mathematics teacher of the class, which created a confidant environment.

After solving the tasks proposed, the teacher collected the written documents produced by the students, in order to allow a more detailed analysis of the presented opinions and explanations.

### **4. Body Mass Index**

The Body Mass Index theme arose in an attempt of raising awareness of the complications that can come from a poorly balanced diet and/or not adequate to their physical needs. Therefore, the purpose was not only to raise awareness of the diseases affecting young teenagers – anorexia/obesity – but also to approach certain mathematical contents. In this specific case, we wanted the students to be able to distinguish ‘algebraic expression’ from ‘formula’ and to identify them in a real context.

In this sense, the students started reading a news article called “Extreme Thinness”, available at <http://caras.sapo.pt/realeza/inglaterra/2011/08/14/magreza-extrema-da-princesa-kate-podera-impedi-la-de-engravidar>. This article refers to Kate Middleton and the fact that her weight is below the acceptable level of thinness. It also mentions that this state is very dangerous for a woman who is trying to conceive and assure the next generation of the British royal family.

The magazine article also states that infertility is one of the consequences of low weight, and for that reason Kate Middleton has to revert this trend of losing weight, which started before her marriage. The article still includes her weight (43kg), her height (1,78m) and her BMI (13,6), so that the readers can better comprehend the situation.

After reading the news, the students asked several questions to the teacher, showing evidence of their lack of knowledge on the subject, as well the will of knowing more about it. This way, the teacher dialogued with the students, questioning them not only about the meaning of the relationship between the BMI and the height of an individual, but also when those values are normal, and the implications when that relationship is not adequate.

The teacher created a task with various questions [6], in order to facilitate the analysis of the news. The first question suggested that the students searched on the Internet how to determine the BMI and its reference values. There was a notorious interest and enthusiasm during this process. The search resulted in several pages where it was only necessary to insert the height (in meters) and the weight (in kilograms) in order to obtain the BMI.

The students easily understood that was not enough to answer to the second question, which consisted in determining the weight range for Princess Kate, so that she would have a normal level of BMI.

Therefore, the necessity of searching for a mathematical model that allowed to calculate the BMI arose.

After finding the formula, the students tried to determine the range asked. Although they had used other mathematic formulas in other contexts, the students had difficulties in answering the question using the formula. In other words, they struggled when they tried to relate the formula with the apparent non-mathematical question. The teacher had to pose several questions as an incentive to the students, so that they would keep trying to complete the task.

The third question provided information about the weight and BMI of another member of a European royal figure and asked the students to calculate the height of

that individual. While solving this question, the students showed more confidence and ease using the BMI formula.

The last question of the first task consisted in commenting a sentence from a British duchess: "a woman is never ... too thin". Some students found the question very pertinent, some found it not related with mathematics.

It is not natural for the students to search about issues that they read or to use previous acquired knowledge to better understand economic, social and political aspects. This attitude might also be related to the fact that the school does not enhance this habit, especially in the context of a Mathematics class.

During the discussion of the last question, the concern and awareness raised in some of the students was visible, in what concerns the power of social media and its influence in the way young people think. They recognised they are not used to question the content of the information they read in the media, assuming it is the truth. Through dialogue, the teacher was able to make the students reflect about a statement, using mathematics.

In the second task it was discussed what was necessary in order to have a healthy life. It was concluded that it would be necessary to keep the weight within the normal level, be physically active, and follow a healthy diet. Besides the quality of the diet, it would be also necessary to know the energetic needs of each individual.

Afterwards, the students were asked to calculate their energetic needs. For that purpose, they used a formula provided for the task, in which they had to take into account their reference weight and their current activity factor.

By solving this task, the students understood that the energetic needs vary and are directly related to gender, age, height and activity factor.

After the discussion of this task, the students showed curiosity in searching the calories contained in the food they usually eat. They were quite surprised with the amount of

calories in a fast food meal. For some, it corresponded to the energetic needs of an entire day.

All this work resulted in the students mentioning that they had no idea that a field like nutrition had such a need for the use of formulas. Some even reinforced the fact that “mathematics is present everywhere” and for that reason it was very important to analyse, comprehend and criticise the mathematical models adopted by society.

## 5. Conclusions

In the past decades, there have been several technological advancements, which allowed for social, political, cultural and economic transformations. This modification has introduced a new challenge for Mathematics Education – to make the students mathematically competent, so that they can understand these hidden mathematical models in daily situations. For that reason, the Critical Mathematics Education was taken into the mathematics classroom.

The tasks proposed and the work methodology adopted in this learning scenario allowed for dialogue to enhance the fundamental characteristics to the critical learning of Mathematics. When the students were discussing the issues mentioned in the news, they would present their justifications based on mathematical concepts, even if they did not understand all the mathematical aspects of the news. Therefore, the mathematical contents approached arouse from the dialogue, the past experiences of the students and the previous acquired knowledge. They arouse naturally, even though the teacher had the intent of approaching those specific contents.

From the data analysis we can highlight the importance of the tasks covered by the students being related with real situations and somehow linked to the students’ backgrounds and foregrounds, for the purpose of triggering in them the intention to learn.

We can also say that with this learning scenario students have been working at the level of critical thinking development and social responsibility using mathematics.

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