Experiments on items of the Brazilian High School Examination

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Abstract. We analysed physics experiments on Brazilian High School Examination (ENEM) items applied between 2009 and 2016. Among 166 items addressing some physics content, we found 49 empirical practical activities that have been classified based on contents and capacities (skills and abilities) described in the High School Curricular Parameters for Natural Sciences (PCNEM). These parameters group the capacities in the dimensions of Representation and Communication, Research and Comprehension, and Sociocultural Contextualization. All practical activities (100%) include the first two dimensions and 27 (51%) include the last one, respectively. We show in detail the categories and the physics content observed in the experiments.

1 Introduction

We analysed physics experiments on the Brazilian High School Examination (ENEM)[1] items applied between 2009 and 2016. The Exam, created in 1998 to evaluate high school student performance, was modified in 2009 for additional and new uses, such as selecting students for government educational programmes and admission to public higher education institutions around the country and in some institutions in Portugal. Worried about student performance on the examination and physics teaching, we analysed the physics experiments through the Exam based on physics content and capacities (skills and abilities) predicted in the High School Curricular Parameters document for Natural Sciences (PCNEM)[2].

The PCNEM document presents Natural Sciences comprising three dimensions, here specified to physics: *Representation and Communication*, which represents the different language forms applied to empirical activities, *Comprehension and Research*, which advocates investigating and understanding how natural phenomena occurs through the practical activities, and the *Sociocultural Contextualisation*, which relates the physical concepts included in the experiments with human history, technological developments, and different cultures.

2 Development

We analysed 11 (eleven) editions of the Exam applied from 2009 to 2016 that had 166 items addressing some physics content, among which 49 items (30%) included some empirical practical activities. These 49 items were classified considering the physics content and also according to the capacities (abilities and skills) involved in the experiments.

The physics content were classified as proposed on the ENEM exam. The item distribuition on the physics content is presented as following: Basic and Fundamental Knowledge (1 item); Movement, Equilibrium, and Physical Law Discovery (15 items); Energy, Work, and Power (2 items); Mechanics and the Universe Functioning (1 item); Electrical and Magnetic Phenomena (11 items); Oscillations, Waves, Optics, and Radiation (12 items); Heat and Thermal Phenomena (7 items). This distribution reflects the empirical practices available particularly in physics textbooks used in Brazil during the same period [3][4].

To classify the capacities (abilities and skills) required in the empirical practical activity items, we considered the categories by dimension as proposed by Barros [5] that studied experiments in physics textbooks. The item distribuition on the capacities is presented as following: *Representation and Communication* [Communication Elaboration (7 items); Symbols

and Codes Articulation (24 items); Reading and Understanding (49 items), subdivided into Textual Reading (15 items) and Textual Reading with Images (34 items)]; *Comprehension and Research* [Relations, Invariants, Transformations and Conservations (28 items); Measures and Quantifications (10 items); Interdisciplinary and Inter-area Relations (5); Explanatory and Representative Models (34)] and the *Sociocultural Contextualisation* [Social Historical Context (5); Relation to Technological Culture (20); Relation to Other Forms of Culture (2).

Considering the *Representation and Communication* dimension, we found Images in 34 (69%) items and Symbols and Codes in 24 (49%) items, meaning that photos, schedules, graphs, symbols, and codes help the students interpret the experiments. In the *Comprehension and Research* dimension, we observed a focus on Representative and Physics Explanatory Models in 34 (69%) items, compared to other categories such as interdisciplinary empirical practical activities that appears in just 5 items (10%). In the *Sociocultural Contextualisation,* we highlight 20 (80%) items related to Technological Culture with devices and technological equipment included in the empirical practical activity items.

3 Conclusion

We deal with the 49 empirical practical activities in the 166 ENEM physics items applied from 2009 to 2016. The practices have been classified based on contents described on the Exam and capacities (skills and abilities) described in the PCNEM document. The contents observed in the items emphasised the classical physics areas such as Mechanics, Electromagnetism and Thermodynamics. Considering the capacities grouped by dimensions in the Parameters document all practices (100%) include the dimensions of *Representation and Communication* and *Research and Comprehension,* while 27 (51%) include the *Sociocultural Contextualisation* dimension

With this research, we aim to guide teachers and students about the physics experiments required on the High School Examination (ENEM). The importance of empirical practical activities in teaching and learning science is well known and the Exam exhibited experiments in 30% of the physics items. As many experiments do not require structured laboratories and can be done using low cost materials available in our daily life, we hope with our results to encourage teachers to explore more empirical practical activities with the students.

References

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