STUDENT UNDERSTANDING OF THE DIRECTION OF FORCE DUE TO ATMOSPHERIC PRESSURE: A TALE OF TWO MODELS

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The direction of force due to atmospheric pressure is a difficult idea for students to understand. We report a study, involving 35 middle school students, which points towards the existence of two contrasting mental models of atmospheric pressure(P_{atm}), which we term the Weight Model (WM) and the Collision Model (CM). Our analysis reveals a predisposition among students to adhere to the WM, wherein they consider P_{atm} akin to a column of air pressing down on the surface of the earth (Tytler,1998). In our presentation, we discuss everyday experiences and textbook presentations as two plausible sources for this predisposition.

Our study involves the analysis of the student discourse as they participated in an activity to estimate the value of atmospheric pressure using a syringe and some easily available materials (Inversin, 1977). Students worked in small groups of 3 to 4, facilitated by instructors. Our goal was to help students engage in discussion, wherein they explicitly articulated their ideas and considered notions from others in an authentic context, thereby paving the way for a revision of their own ideas. The activity had the following components:

a) A pre-activity questionnaire: A set of 6 questions, aimed at eliciting students' prior conceptions and basic understanding related to atmospheric pressure. These written responses subsequently served as the basis for discussion among students, within and across student groups.
b) A demonstration to show the action of atmospheric pressure: Instructors illustrated the action of atmospheric pressure on the syringe and its directionality. The demonstration sought to scaffold students' thinking while engaging with the difficult notion of the direction of force due to atmospheric pressure.
c) Activity to estimate the magnitude of atmospheric pressure: In this part the students have to design an experiment using the syringe to calculate the value of atmospheric pressure. The experimental design involves a balancing condition between 3 forces: static friction between the barrel and piston of the syringe, force due to atmospheric pressure and weight hung on the syringe.
d) Post activity questionnaire: The final part of the activity is a set of questions aimed at checking whether there was any change in student response patterns pertaining to atmospheric pressure.

Our analysis reveals that the activity and associated discussions show potential to facilitate students' transition from the WM to the CM. We present evidence of modest conceptual gains characterized by micro-transitions in students' problem-solving strategies, being increasingly inclined towards the canonical CM rather than the intuitive WM of the atmosphere. We also present some problematic discourse patterns, which are likely widespread in traditional lecture-based Physics classrooms.

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