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Promoting in solving electric circuit problems via voltage tracking and division

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Abstract :
Despite a tremendous success in boosting students learn electrical analogies for science education, it remains a challenge to extend such strategy for formally constructing equations related to the Ohm's law in order to solve electrical problems based on series and parallel circuits. Unlike most traditional works of teaching technique that focus mainly on the current, an alternative approach with highlighted voltage is served as a guidance to help students solve the problems and develop a better understanding of direct circuits. To this end, we present a design of teaching method so-called voltage tracking and division. We report results from a study in which we used a set of pretest, posttest, and delayed posttest to evaluate the change in 35 sophomore students, major in general science of education, as a result of their participation in the electricity and energy course that comprised a 4-hours intensive class and 1-month follow-up examination. Through the employment of our method, students showed significant gains from pretest to posttest as well as that on the delayed posttest compared to the pretest. These results suggested that voltage tracking and division method facilitated the development of students' ability in solving electric circuit problems and also provided the persistence of such understanding. We envisage that our findings would evoke teaching tools that benefit from emphasizing voltage via the voltage tracking and division method to enhance the deepen understanding of students in solving circuit problems.

Keywords: Science teaching, Physics teaching, voltage tracking and division, problem solving, electric circuits

Introduction

Encouraging students learn scientifically analogies are remedial strategies for science education (Weller, 1970; Dagher, 1995; Treagust et al., 1998; Aubusson, 2009). Despite their widespread applications in physics (Jonāne, 2015; Fortman 1993; Cruz-Hastenreiter, 2015; Parappilly et al., 2018), particularly in electricity (Stocklmayer and Treagust, 1996; Sengupta and Wilensky, 2016; Ugur et al., 2012; Oh et al., 2012), the use of analogies has been demonstrated only with limited success (Brown and Salter, 2010; Goris, 2016). For example, some analogies such as the water, gravitational, or anthropomorphic models are introduced to the students as the alternative approaches to provide the basic formal tuition in the topic of electrical circuitry while they do little to foster deep developing technical expertise in calculation (Stocklmayer and Treagust, 1996). Accordingly, an extended work to formally construct the understanding of the nature of electricity thus remains challenging.

Unlike most traditional works of teaching technique that concentrate mainly the current in introductory electricity (Young et al., 2016; Engelhardt and Beichner, 2004), an alternative approach so-called an emphasis on voltage helps students develop a better understanding of direct circuits than traditional method (Rosenthal and Henderson, 2006). This notion is supported with an observation of understanding failure to explain the effect of adding cells in single or multiple loops, as students tends to use reasoning based on current and resistance where reasoning based on voltage is a necessary (Smith and Kampen, 2011). Consequently, teaching method with highlighted voltage aimed at providing guidance to students is essential (Millar and Beh, 1993).