Misconceptions regarding direct-current resistive theory in an engineering course for N2 students at a Northern Cape FET college

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Abstract

The aim of this study is to ascertain what misconceptions N2 students have about DC resistive circuits and how screencasts could effect on the rectification of these misconceptions. This study was conducted at the Kathu Campus of the Northern Cape Rural Further Education and Training College in the town Kathu in the arid Northern Cape. The empirical part of this study was conducted during the first six months of 2013. A design-based research (DBR) method consisting of four phases was used. DBR function is to design and develop interventions such as a procedure, new teaching-learning strategies, and in the case of this study a technology-enhanced learning (TEL) tool (screencast) with the purpose of solving a versatile didactic problem and to acquire information about the interventions of the TEL tool (screencast) on the learning of a student. In the first and second phase of DBR quantitative data for this research were gathered with the Determining and Interpreting Resistive Electric circuits Concepts Test (DIRECT) in order to determine the four most common misconceptions. The DIRECT test was conducted in the first trimester to find the misconceptions; the test was conducted in the second trimester also to confirm the misconceptions. Further quantitative data were collected from a demographic questionnaire. The qualitative data were collected by individual interviews in the fourth phase of the research project. Phase three of this study was the development of screencasts in the four most prominent misconceptions in DC resistive circuits of the students. The respondents of this study were non-randomly chosen and comprised of two groups, one in the first trimester of the year and one in the second trimester of the year, which enrolled for the N2 Electrical or Millwright courses. The respondents were predominant male and representing the three main cultural groups in the Northern Cape namely: Black, Coloured and White. The four misconceptions on DC resistive circuits that were identified were: (i) understanding of concepts, (ii) understanding of short circuit, (iii) battery as a constant current source, and (iv) rule application error. Screencasts clarifying the four misconceptions were developed and distributed to the respondents. On the foundation of the results of this research, it can be concluded that the students have several misconceptions around direct current resistive direct current circuits and that the use of TEL like screencasts can be used to solve some of these misconceptions. Screencasts could supplement education when they were incorporated into the tutoring and learning for supporting student understanding. The results of this research could lead to the further development and refinement of screencasts on DC resistive circuits and also useable guidelines in creating innovative screencasts on DC resistive circuits.

Keywords: Industrial Electronics; DIRECT test; misconceptions; screencasts; design-based research; direct current resistive circuits; FET College; conceptual-theoretical framework; coaching; and scaffolding.

Opsomming

Die doel van hierdie studie was om te bepaal watter wanopvattings N2 studente het met betrekking gelykstroom resistiewe stroombane en of “screencasts” diesulke wanopvattings effektief kan aanspreek. Hierdie studie het plaasgevind op die Kathu-kampus van die Noord-Kaap Plattelandse Verdere Onderwys en Opleiding Kollege, in die dorp Kathu in die dorre Noord-Kaap. Die empiriese gedeelte van die studie is gedurende die eerste ses maande van 2013 uitgevoer. 'n Ontwerpgebaseerde navorsings (OGN) metode bestaande uit vier fases het die studie ondersteun. OGN het betrekking op prosedures, nuwe onderrig-leer strategieë, en in hierdie geval van hierdie studie 'n tegnologiese onderrig- en leerproduk (screencast) tot gevolg gehad met die doel om 'n komplekse didaktiese probleem op te los en inligting oor die ingrypings te bekom en ‘n produk (screencast) te ontwerp, ontwikkel en die gebruik te evalueer ten aansien van leerstrategieë van studente. In die eerste en tweede fases van die OGN het gebruik gemaak van die kwantitatiewe data ingesamel volgens die Determining and Interpreting Resistive Electric Circuits Concepts Test (DIRECT) om die vier mees algemene wanopvattings met betrekking tot gelykstroom resistiewe stroombane te bepaal. Die DIRECT toets is tydens die eerste trimester uitgevoer om studente wanopvattings te bepaal en is gedurende die tweede trimester herhaal om die diesulke wanopvattings te bevestig. Addisionele kwantitatiewe data is deur middel van 'n demografiese vraelys ingesamel. Die kwalitatiewe aspekte van die navorsing het langsaan die kwantitatiewe aspekte plaasgevind het betrekking gehad op data-analise wat tydens individuele onderhoude ingesamel is tydens die tweede en vierde fases van die projek. Tydens fase drie van hierdie studie het die ontwikkeling van die screencasts plaasgevind. Hulle het die vier mees opmerklike wanopvattings van studente met betrekking tot gelykstroom resistiewe stroombane van die studente aangespreek. Die gerieflikheidsteekproef van respondente van hierdie studie het bestaan uit twee groepe: een gedurende die eerste trimester van die jaar en een in die tweede trimester van die jaar. Die respondente was ingeskryf is vir die N2 Elektriese of Millwright kursusse en was oorwegend manlik en het bestaan uit die drie mees prominente kultuurgroepe in die Noord-Kaap: Swart, Bruin en Wit. Die vier belangrikste wanopvattings wat met betrekking tot gelykstroom resistiewe stroombane wat geïdentifiseer was, is: (i) begrip van konsepte, (ii) begrip van kortsluitings, (iii) batterye as 'n konstante stroom bron, en (iv) reël-toepassings foute. Screencasts ter verduideliking van die vier wanopvattings is ontwikkel en aan die respondente beskikbaar gestel. Op gronde van die resultate van die evaluering van studente se persepsies en ervarings met betrekking tot die screencasts kon bevestig word dat die studente wanopvattings met betrekking tot gelykstroom resistiewe stroombane het en dat die gebruik van tegnologiese hulpmiddels soos screencasts bygedra het om sommige van die wanopvattings op te hef. Screencasts kan onderrig aanvul en kan in die onderrigsituasie inkorporeer word en ter ondersteuning (scaffolding) van leerinhoude met betrekking tot gelykstroom resistiewe stroombane aan studente. Die resultate van hierdie navorsing het ontwerpbeginsels bepaal wat gebruik kan word in die verdere ontwikkeling en verfyning van screencasts vir gelykstroom resistiewe stroombane. Die navorsingverslag bied ook riglyne aan vir die skep van innoverende screencasts van gelykstroom resistiewe stroombane.

Sleutel woorde: Industriële Elektronika; DIRECT toets; wanopvattings; screencasts; ontwerp-gebaseerde navorsing; resistiewe stroombane; VOO Kollege; konseptuele-teoretiese raamwerk; pedagogiese ondersteuning; tegnologie-ondersteunde leer.

Solemn Declaration

Certificate of Proofreading

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I hereby declare that I have linguistically edited the dissertation submitted by Mr Christiaan Beukes for the MEd degree:

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Ethics Approval

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List of Acronyms

DBR	Design based research
DC	Direct current
DE	Distance education
DIRECT	Determining and Interpreting Resistive Electric Circuits Concepts Test
HSRC	Human Sciences Research Council
ICT	Information and Communication Technology
NCRFET College	Northern Cape Rural Further Education and Training College
N	Nated
SIP's	Strategic Infrastructure Projects
TEL	Technology-enhanced learning
TTB	Technical Test Battery