



# Wearable Textiles to Support Student STEM Learning and Attitudes

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## Abstract

Electronic textiles, especially those that can be worn (wearable textiles) are gaining traction within the P12 education community. The technology provides hands-on learning that is both exciting and personally relevant, especially for females, who have historically responded positively to aesthetics and textile design. A number of studies have examined the potential of wearable technologies in education but they generally use small samples, mostly engage secondary school students, and are carried out in either formal or informal settings. In contrast, this study utilized a large sample of 808 upper elementary students and involved both in- and out-of-school learning contexts led by formal and informal educators. The present study used a quasi-experimental, prepost design with two groups (treatment and control) to measure the impact of a wearable technology intervention on students' (a) knowledge of circuitry, programming, and engineering design and (b) self-efficacy in making a wearable e-textile product. The three-level multilevel (i.e., children nested within teachers which were nested within schools) ANCOVAs were estimated for each outcome of interest (knowledge of circuitry, programming, engineering design, engineering self-efficacy, and programming self-efficacy). Results indicate that wearable technology's integration of engineering, computing, and aesthetics promises to be an excellent interdisciplinary context to support students' STEM learning and attitudes at the upper elementary level. However, differential results between males and females underscore the need to infuse gender-appropriate pedagogical practices to insure that females develop the needed self-confidence to successfully complete tasks involving these two skill areas.

**Keywords** Wearable technology · STEM education · Engineering design · Self-efficacy

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## Introduction

Wearable technologies are touted as one of the key technologies in Horizon Research's *Technology Outlook for STEM + Education 2012–2017* (Johnson et al. 2012); the technology is described as providing an “engaging set of design and engineering challenges that cut across a wide range of the STEM disciplines” (p. 16). Wearable technology, a field of electronic textiles, refers to devices that can be worn as an accessory or item of clothing. Recent inventions such as Google Glass, Apple Watch, and the FitBit are examples of “hard” wearable technology and are not traditionally considered learning tools. The educational impact of this technology derives from its “soft” aspect—electronic textiles, sewable circuitry, and conductive threads that bring together engineering and aesthetics to make products that are “soft, colorful, approachable, and beautiful” (Buechley et al. 2013, p.1). With wearable textiles, technology that is normally hidden becomes visible. Computing becomes personally relevant when it is combined with textiles, producing a product that the maker can actually