ISBN: "978-93-87901-17-9" 10th, 11th, 12th December, 2020

ENHANCING STUDENTS' CREATIVE ABILITIES BY TEACHING ENGINEERING GRAPHICS IN HIGHER EDUCATION

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Annotation
Creative thinking is an essential part of learning for sustainability, as recent studies indicate. Creativity enables the engineer to find solutions for the design of a new product or for the improvement of one already designed, to make it more sustainable. However, currently,engineering education does not usually assess academic performance in terms of creativity, and although interest in creative processes in engineering is growing, its implementation in the classroom is still scarce. In the present study, a creativity workshop was conducted in order to find multiple solutions to the problem posed, in accordance with divergent thinking. The workshop was based on a 3D CAD modelling activity, and the students needed to give different 3D design solutions starting from a two-dimensional shape. The participants were 72 engineering students from the engineering graphics subject in the degree in agricultural engineering and rural areas. Nine different creative components were evaluated. That way, not only was a generic measure of creativity obtained, but it was also possible to know the evolution of the student after the workshop for each of the components of creativity separately.

Key words: creative, global, ESL, simple, college

Creativity is often perceived to be an elusive and ill-defined phenomenon. Despite its complexity creativity can be the subject of inquiry like any other abstract concept. Current research into higher education confirms that creativity is more than a disposition, talent or skill possessed only by exceptionally gifted students. Rather, the argument for "second generation" creativity supports the proposition that all individuals have the potential for creative ways of learning, thinking and being; creativity can be fostered, and needs to be designed for in curricula. While Australian universities commonly list creativity as a graduate capability, there is evidence that higher education practitioners have difficulties expressing, developing and measuring creativity. The problem is not that creativity is absent from curricula, but that it may be implicit rather than explicit, and that analytic modes of knowledge generation tend to be prioritised over the creative in contemporary higher education. Teaching for creativity and teaching creatively remain problematic. There are studies that indicate that creative thinking is an essential part of learning for sustainability [1,2]. Engineering needs different, innovative and creative solutions for a world in constant change. Creativity is an important tool in the search for a more sustainable future, directly linked to innovation and creative problem solving, claimed Hopkins [3], UNESCO chair in Reorienting Teacher Education to Address Sustainability. A creative engineer is able to find different solutions for the design of a new product or for the improvement of one already designed to make it more sustainable. Creativity facilitates offering different solutions in a useful and novel way [4–6]. Other authors [7,8] define this term as "general creativity". In a stricter sense, "creativity in engineering" is understood as a way of thinking that brings new ideas which are original and easy to apply in a functional and practical way [9,10]. Other authors [11] call "functional creativity" the novelty of needing to satisfy functional requirements, through the combination and connection of ideas in new ways. Engineering and creativity, therefore, have a close relationship. Some authors even think that, "If engineers are not creative, they are not engineers" [12] (p. 22). Creativity is a necessary engineering skill, so engineers have a wide field for the support of creative skill development. Nevertheless, engineering education does not usually assess academic performance in terms of creativity. Although the literature on creativity has grown exponentially over the last few decades, research into its development in higher

education cross-disciplinary contexts is nascent. In addition, there is little research that acknowledges the impact of the complex, technology-rich environments in which educators operate, where the goal is to promote student creativity. Therefore, the aim of this study was to explore higher education practitioners' concepts of creativity, and the means by which they design for creative learning and teaching. A mixed methods approach framed the inquiry, underpinned by a social constructivist epistemology. Data was collected via a survey of tertiary educators and five case studies of exemplary practitioners. Descriptive and inferential statistical methods were employed to interpret the quantitative data, and a new variant of grounded theory, informed grounded theory applied for the qualitative data analysis. The findings indicated that creativity remains a polythetic construct, valued for its place in student learning. Not all practitioners, however, are confident in their ability to design for creative learning outcomes, particularly where the use of digital learning technologies compounds this already complex task. Despite growing interest in creativity, it is not clear from the literature that university educators in the main know how this capacity can be promoted in curricula (European University Association, 2007) or developed through creative teaching practice within disciplines (Williams & Askland, 2012). While creativity was once thought to be the preserve of exceptionally gifted and talented individuals, researchers now argue that most individuals can develop their creativity (e.g. Craft, 2006a; Herbert, 2010; McWilliam & Dawson, 2008). McWilliam and Dawson (2008) maintain that small "c", or "second generation" creativity (p. 663) can and should be fostered, and that creativity is core business for university educators. Given the importance assigned to creativity and innovation in the creative economy (Florida, 2002; Howkins, 2010a), and its personal and social value (Csikszentmihalyi, 1997; Robinson, 2011), there is value in exploring conceptions of creativity in greater depth, to discover what teachers mean when they ask students to "be creative". There are pedagogical models on which research, theory and practice can build, many of which come from the arts and the creative industries (Eisner, 2002; Fleming, 2008; Robinson, 2011). Other disciplines such as engineering and business, however, also provide innovative examples and alternatives from which lessons can be learned (e.g. Baillie, 2002; Barrow, 2010; Kazerounian & Foley, 2007; Petocz, Reid, & Taylor, 2009; Swirski, 2012). The literature around the contemporary student experience and interpretation of creativity, nonetheless, lags somewhat (but see Reid & Petocz, 2004; Reid & Solomonides, 2007). As the literature grows, and new creative pedagogical models emerge, it is timely to investigate contextual factors that impact the development of creativity: this includes the technologies that either contribute to or limit creativity in practice. The technology-enhanced learning (TEL) environments (Goodyear & Retalis, 2010) in which teachers now operate in higher education rely on integrated, creative pedagogical practice to be effective. Given the importance of creativity to learning and teaching, the overall aim of the research was to investigate how educators foster and design creativity in higher education. The goal was to shine a light on the issues and discover more about the meaning and value of creativity in the learning and teaching context, how it is understood by practitioners personally, and as a student learning outcome, and how it can be designed for in practice. For example, over the past 20 years, the population in our country has increased, state-owned preschool institutions have decreased by more than 45 percent. The coverage of children in these camps is only 30 per cent so far. How important is the pre-school education system, it is possible to know from the opinions of our president about the difference in the level of thinking of a child who has not gone to kindergarten with a child who has received a kindergarten education [8].

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