Contemporary Educational Psychology 53 (2018) 27–44

Contents lists available at ScienceDirect

Contemporary Educational Psychology

journal homepage: www.elsevier.com/locate/cedpsych

Career aspirations, perceived instrumentality, and achievement in undergraduate computer science courses☆

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ARTICLE INFO

Keywords:
Perceived instrumentality
Career aspirations
Computer science education
Motivation
Future time perspective

ABSTRACT

This research investigated the relationships among undergraduate computer science students' computer-science-related career aspirations, perceived instrumentality (PI) for computer science courses, and achievement in those courses. Specifically, the two studies examined (a) change in PI and career aspirations during a single semester, (b) the relationship between change in career aspirations and change in PI, and (c) the influence of career aspirations, PI, and change in career aspirations and PI on achievement in computer science courses. Findings from both studies revealed that students experienced a decrease in endogenous PI and career aspirations and an increase in exogenous PI during the semester. Study 1 showed that non-computer science majors experienced greater shifts in PI and career aspirations than computer science majors. Study 2 showed that the change in PI happened in parallel and was curvilinear, with more change happening in the first half of the semester than the second half. Both studies also showed that computer-science-related career aspirations were associated with PI, and that aspirations and PI had a stronger relationship with scores on a computer science knowledge test than with course grades. Implications and directions for future research are discussed.

1. Introduction

Education is a long-term endeavor directed at distal outcomes. The career-oriented utility of a college education is a primary reason students choose to attend college and select a specific major (Bui, 2002; Montmarquette, Cannings, & Mahseredjian, 2002). Despite this long-term nature of post-secondary education, there has been little research in educational psychology examining how students' career aspirations may relate to motivation and achievement in their courses. Within educational psychology, motivation for distal outcomes has been understudied relative to more proximal motivational constructs such as interest, self-efficacy, and achievement goals. In fact, many theories of motivation such as self-determination theory, intrinsic motivation, mindfulness, and flow, while perhaps recognizing that there might be meaningful distal outcomes, emphasize focusing on the immediate experience of the current task for optimal motivation. The two studies reported in this paper were designed to address this gap in the research literature using the lens of Future Time Perspective theory (Husman, Brem, Banegas, Duchrow, & Haque, 2015; Husman & Lens, 1999; Kauffman & Husman, 2004a, 2004b; Simons, Vansteenkiste, Lens, & Lacante, 2004; Zimbardo & Boyd, 2015).

Colleges and universities have been increasing their focus on students' post-graduation employment (Calderon & Jones, 2017), suggesting that institutions recognize the relationship between post-secondary education and career options. At the individual level, many students choose to go to college to prepare for a future in a desired or desirable career, even if they have not identified a specific career when beginning their college education. Preparation for a future career is especially salient for students in the science, technology, engineering, and math (STEM) fields. In recent years, STEM fields have received a great deal of attention from educators, education researchers, and policy makers. This attention is due in part to the recently documented and projected above-average growth rates for jobs in STEM fields and the necessity of post-secondary education for most of these STEM jobs (Carnevale, Smith, & Strohl, 2013; Langdon, McKittrick, Beede, Khan, & Doms, 2011). Post-secondary STEM degrees require completion of a lengthy sequence of coursework over many years. Motivation toward the ultimate career must be maintained for many years of difficult, demanding coursework with rigorous technical content that requires considerable effort and persistence.

☆ This work is based on an earlier work: "Perceived instrumentality and career aspirations in CS1 courses: Change and relationships with achievement," in *Proceedings International of the 2016 ACM Conference on Computing Education Research (ICER'16)* (pp. 13–21), September 8–12, 2016, Melbourne, VIC, Australia ©ACM, 2016. DOI: https://doi.org//10.1145/2960310.2960320.

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https://doi.org/10.1016/j.cedpsych.2018.01.006

Our objective in these studies was to utilize the Future Time Perspective theory constructs of value and connectedness to enhance understanding of how distal career outcomes affect computer science (CS) students' motivation for their course-work. Specifically, we examine how change in CS students' career aspirations across a semester long course is associated with changes in students' perceived instrumentality for the course and how changes in aspirations and perceived instrumentality are related to students' learning outcomes.

1.1. Future time perspective theory

The umbrella term *time perspective* encompasses a broad set of theories about how an individual's perception of time influences his or her psychological functioning, motivation, and cognition (Husman & Lens, 1999; Nuttin & Lens, 1985; Zimbardo & Boyd, 2015). Within time perspective, particular focus has been placed on the role of future thinking. As a psychological theory, Future Time Perspective (FTP) concerns the extent to which individuals integrate an envisioned future with the present (Husman & Lens, 1999). FTP is conceptualized as a multi-faceted, hierarchical construct (Hilpert et al., 2012; Husman, Hilpert, & Brem, 2016; Husman & Lens, 1999; Husman & Shell, 2008; Simons, Vansteenkiste, et al., 2004). FTP consists of four constituent constructs: connectedness, valence/value, distance, and speed (Husman & Lens, 1999; Husman & Shell, 2008). Although research supports that all of these constituent constructs have important influences on future thinking (Husman & Lens, 1999), in academic settings, emphasis has been placed on connectedness and valence/value (De Volder & Lens, 1982; Husman & Lens, 1999; Shell & Husman, 2001, 2008).

1.1.1. Connectedness and perceived instrumentality

Future outcomes and goals are only motivating in the present if persons perceive that present actions can influence the attainment of those outcomes and goals. FTP Connectedness reflects the extent to which persons see future outcomes as contingent or dependent on present behaviors or actions (Hilpert et al., 2012; Husman & Lens, 1999; Husman & Shell, 2008; Husman et al., 2015, 2016; Shell & Husman 2001). Connectedness is similar to other beliefs that outcomes are contingent or dependent on personal actions such as Locus of Control (Rotter, 1966), outcome expectancies (Bandura, 1977) or utility value (Wigfield & Eccles, 2000). What distinguishes connectedness from these similar contingency beliefs is that connectedness is about contingent connections between the present and outcomes occurring in the distant future.

Connectedness is hierarchical (Hilpert et al., 2012; Husman et al., 2015, 2016). General connectedness is a global belief that future outcomes are or are not contingent on or connected to present behavior and actions (Husman & Lens, 1999; Husman & Shell, 2008; Husman et al., 2016; Shell & Husman, 2001). Domain connectedness is a more focused belief that outcomes in a specific domain, such as one's career or one's personal life, are or are not contingent on present actions and behaviors (Hilpert et al., 2012; Husman et al., 2015, 2016). Perceived instrumentality (PI; De Volder & Lens, 1982; Greene, Miller, Crowson, Duke, & Akey, 2004; Husman, Derryberry, Crowson, & Lomax, 2004; Husman & Hilpert, 2007; Miller, DeBacker, & Greene, 1999; Simons, Dewitte, & Lens, 2004) reflects the contingency between specific actions, behaviors, or activities and attainment of future outcomes. In the academic domain, PI reflects contingencies between behaviors such as studying or taking specific courses and attainment of future academic, personal, or career goals or outcomes.

In FTP theories, both general and domain specific connectedness are seen as dispositions that reflect a person's general tendency to connect the future to the present. Although not viewed as a personality or temperament characteristic, general and domain connectedness, like Locus of Control (Rotter, 1966), are seen as relatively stable in the short term (Husman & Lens, 1999; Husman et al., 2016).

PI, however, deals with the contingent connection of specific behaviors to future outcomes. PI, like other contingency beliefs, is derived primarily from experience, both personal and vicarious (see discussions of underlying neural and cognitive mechanisms in Shell et al. (2010) and Shell and Flowerday (in press)). This makes PI, like specific outcome expectancies, considerably more malleable and changing. If studying does not lead to better grades, the PI of studying will soon decrease. Within the general hierarchical structure of connectedness, persons with a high level of general and domain connectedness perceive more and stronger instrumentalities between their behavior and future outcomes (Hilpert et al., 2012; Husman & Lens, 1999; Husman et al., 2016). These higher levels of general or domain connectedness can insulate PI from declining rapidly for specific non-contingent incidents, but connectedness cannot keep PI from declining if contingencies are not maintained. A student with high general or academic connectedness may still believe that studying is instrumental to grades even if that was not true in one course. However, if it is not true in most courses, connectedness will not be enough to maintain PI for studying. PI requires that experience confirms the instrumental connection.

Because PI is anchored in experience, it is subject to change as environmental conditions and context change. In the academic setting, studies have found that PI is influenced by classroom context (Greene & DeBacker, 2004; Husman et al., 2016). Theoretically, PI would be expected to change within an academic class as students assessed the instrumentality of classroom content and activities as they experience it. However, studies of the extent to which PI changes during specific courses are lacking.

1.1.2. Value and valence

Valence and value refer to the importance of future outcomes. From a motivational perspective, it is not enough to know that an outcome is contingent on some behavior; one has to see the outcome as valuable or important enough to pursue. Generally, within FTP theories (see Husman & Lens, 1999), valence is seen as a disposition to ascribe a high value to goals that can only be attained in the distant future. Husman and her colleagues (Husman & Lens, 1999; Husman & Shell, 2008; Shell & Husman, 2001, 2008) operationalize this disposition as the general tendency to more highly value future goals relative to short-term immediate goals. This general FTP valence will strengthen the motivational impact of any specific future goals; persons with high valence will derive more motivation from any future goal than a person with low valence who has the same goal. But, FTP valence is not itself a specific goal or desired outcome.

The future, however, consists of specific goals. At the highest level, value concerns the ability to conceptualize a personal future life course. FTP theory (Husman & Lens, 1999) views future life goals similarly to Markus' (Markus & Nurius, 1986) conception of future possible selves. A future possible self is a potential life path or outcome that could be personal, such as being a good spouse or parent; academic, such as attaining a college degree; or career, such as becoming an engineer. Markus and Nurius (1986) argued that future possible selves can have a motivational function by providing "incentives for future behavior" (p. 955). From the perspective of FTP, future possible selves and other types of life outcomes are motivational to the extent that they are valued (Shell et al., 2010). This value must then lead to a specific commitment or aspiration to pursue that future self. This is the difference, for example, between knowing that an engineer is something one could possibly become and saying, "I am going to be an engineer." This type of career aspiration means that the person values this future career highly enough to want to attain it. Commitment to this aspirational career is evidenced both by the expressed aspiration to pursue the career and by taking concrete steps and actions to realize this career goal.

Although FTP valence is seen as more dispositional, specific future goals or future possible selves are theoretically viewed as quite malleable (Husman & Lens, 1999; Husman & Shell, 2008; Husman et al., 2015; Markus & Nurius, 1986). To have a future possible self, one must know that the possible self exists (Markus & Nurius, 1986; Shell et al.,