Chapter 1 - Introduction

Introduction

Computation has transformed the modern world to such an extent that it is difficult to find an area of society untouched by it. As a result, Computer Science has emerged as both an important field of study and a desirable career path, which attract thousands of prospective college students of Computer Science every year. In doctoral-granting institutions in the United States and Canada, enrollment in Computer Science undergraduate majors more than tripled from 2006 to 2011 and more than doubled from 2011 to 2016 (Computing Research Association, 2017). Good financial prospects might partially account for this boom, as earnings have been demonstrated to be a significant motivator for undergraduate major choice (Baker, 2018; Ko & Jun, 2015; Montmarquette, Cannings & Mahseredjian 2002). A 2017 survey from the National Association of Colleges and Employers (NACE) found that Computer Science majors had the highest average starting salaries of all surveyed categories, which included engineering, business, social sciences, and humanities majors, among others. All these points make Computer Science learners an important population to study.

There exists plenty of anecdotal evidence about how much students of computer science learn on their own. Scholarly articles about this subject usually acknowledge this informally as a common-sense, self-evident truth within the discipline (Boyer, Langevin & Gaspar, 2008; McCartney, Boustedt, Eckerdal, Sanders, Thomas & Zander, 2016). Non-scholarly sources provide additional support: in its 2019 yearly survey, Stack Overflow, a popular website for questions and answers about programming, had 85.5% of over 84.000 respondents say that they had taught themselves a new programming language, framework, or tool without taking a formal course. In the same survey, over 62% of respondents majored in Computer Science. These results

indicate that Computer Science learners pursue self-direction in learning even when enrolled in a formal educational setting.

Statement of Problem

Although non scholarly sources provide ample evidence that computer science learners learn on their own, scholarly literature on the subject remains sparse. This is especially noteworthy considering three factors. First, that the phenomenon of self-direction in learning in computer science is so common that, as Zander et al. (2012) states, it becomes something that students are expected to do in addition to learning from their classes. Second, that, in the adult education literature, self-directed learning of other topics in adulthood is well-researched. Third, the high enrollment trends in computer science over the last decade indicate that this is an issue that affects a large population. As such, it is important to understand how these learners engage in self-directed learning so that faculty and administrators can provide them with the adequate support and resources that they need.

Purpose of Study

The purpose of this study was to examine the self-directed learning readiness of Auburn University's Department of Computer Science and Software Engineering (CSSE) undergraduate and graduate students, measured through the Personal Responsibility Orientation to Self-Direction in Learnin Scale (PRO-SDLS) (Stockdale & Brockett, 2011).

Five research questions guide the present study:

1. How do Auburn University's CSSE students score in the PRO-SDLS?
2. Are there statistically significant differences in PRO-SDLS score by gender?
3. Are there statistically significant differences in PRO-SDLS score by ethnicity?
4. Are there statistically significant differences in PRO-SDLS score by age?

5. Are there statistically significant differences in the PRO-SDLS score among freshman, sophomore, junior, senior, and graduate CSSE students?

Chapter 2 – Literature Review

Self-Direction in Learning Within Adult Education

Self-directed learning among adults is a concept perhaps as old as civilization itself. According to Kulich (1970), before the "fairly recent wide-spread and readily available schooling for everybody, self-education was the prime way for man to cope with the world around him" (p. 1). For instance, he found evidence of self-directed learning among ancient Greek philosophers. Kulich notes that Socrates and Plato spoke about self-education as an ideal quality and as a virtue of the wise, whereas Aristotle regarded it as a potentiality that exists in all individuals and could be developed by themselves or by a teacher. From these early philosophers, Kulich traced a history of self-directed learning that encompasses much of Western history, drawing examples from instructional manuals in the 1500s to correspondence courses in the United States during the 1960's.

Even though self-learning is an ancient concept, scholarship on the subject is comparatively recent (Candy, 1991). Multiple sources (Candy, 1991; Merriam & Caffarella, 2007; Brookfield, 1985; Hiemstra, 1994; Brockett & Donaghy, 2005) point to two pioneering studies as the earliest and most influential in the field of self-directed learning in adulthood.

The first of them is *The Inquiring Mind*, a 1961 study by Cyril O. Houle. Houle's study, formatted as a "brief, lucid, scholarly essay" (Candy, 1991, p. 25), interviewed 22 adults of diverse backgrounds who were "conspicuously engaged in various forms of continuing learning" (Houle, 1961, p. 13) to such an "outstanding degree that they could be readily identified for me by their friends or by the counselors and directors of adult educational institutions" (p. 4). About

these adults, Houle wanted to ask "the usual questions—who, what, when, where, and why—and examine such other more complicated matters as may seem appropriate (p. 4).

Houle's mention of "the usual questions" reflects his preoccupation with distinguishing this investigation from other works in adult education at the time. These studies focused on participation in established educational institutions, such as universities, libraries, evening schools, and community centers. In contrast, the starting point for Houle's study was "not the act of participation, but the participant" (p. 9). This, he argued, would lead to a deeper understanding of the reasons and processes adults use when engaging in continuing education, as well as encompass a broader population than the well-educated, high-income adults that typically frequented more established educational institutions.

Houle found that, among his participants, there were three different types of continuing learners. First, there were *goal-oriented* learners, for whom education was usually a means of attaining a particular goal, such as a certificate or promotion. Second, there were *activity-oriented* learners, who participated in learning activities for various reasons, including to stave off loneliness, to find a spouse, and to comply to family or cultural traditions. These learners primarily sought social contact, and as such, placed more importance on the act of learning itself, rather than the content. But it was the third group, which differed markedly from the other two, that was most interesting for the field of self-directed learning (Brockett & Donaghy, 2005). These were the *learning-oriented* learners, who were moved chiefly by an intrinsic "desire to know" (Houle, 1961, p. 25). For them, learning was an innately enjoyable experience and a constant throughout most of their lives.

Houle intended his study as a primer on the subject of "outstanding" continuing learners, rather than a thorough description, and called for "later and fuller development" (p. 4) on the

study of such learners. And, indeed, a few years later, one of his doctoral students would focus his attention on learning-oriented individuals (Hiemstra, 1994).

This student was Allen Tough, a Canadian educator whose 1971 study *The Adult's Learning Projects* is the second influential work on self-direction most consistently identified in the literature. Tough attributed his interest in self-directed learning to a graduate course he took in 1963, taught by Houle (Tough, 1967). Tough did his doctoral dissertation on that subject, which he published in a condensed form in 1967. Four years later he published *The Adult's Learning Projects,* which built upon data from his dissertation and subsequent studies on the subject.

Tough, who was inspired by Houle to direct his efforts to individuals rather than institutions (Tough, 1971, p. 2), focused his study on the "highly deliberate" efforts adults undertake to gain knowledge, skills, or in other ways effect change in themselves. Tough calls these efforts *learning projects*, which he defines as

> a series of related episodes, adding up to at least seven hours. In each episode, more than half of the person's total motivation is to gain and retain fairly clear knowledge or skill, or to produce some other lasting change in himself. (p. 7)

This definition, with its careful attention to the motivation, content, and duration of learning, is meant to "separate major learning efforts from those that are not very significant or intensive" (p. 15).

In *The Adult's Learning Projects*, Tough provides a general description of learning efforts in adulthood. He found that adults undertook a median of 8 major learning projects per year, and almost 90% of adults undertook at least one learning project a year. In most cases, these learning projects were motivated by "some fairly immediate problem, task, or decision that demands

certain knowledge and skill" (p. 40). Rarely were adults interested in learning the entire body of knowledge of a field.

Because Tough's intentions were to encompass all adult learning, the learning projects he described include participation in common educational settings (such as a classroom), where someone else plans and often facilitates learning. However, in 68% of cases, the adults themselves planned their learning projects. By "planning" a learning project, Tough referred to the decision regarding the content, method, schedule, and pace of learning episodes. Once planned, the adult may rely on different sources to deliver the learning content, which might include human resources (such as a teacher) or non-human resources (such as a book). Tough identified 13 "clusters" of steps that adults took when planning a learning project. These steps (which appear here condensed, for conciseness) include:

- Deciding what knowledge and skill to learn
- Deciding the specific activities, methods, resources or equipment for learning
- Deciding where to learn and setting up that space accordingly
- Scheduling the learning project, which includes setting deadlines, deciding when to begin, and determining the pace of learning
- Estimating current level of knowledge and skill
- Obtaining the resources necessary for the learning project, including saving or obtaining money for acquiring these resources
- Finding ways to increase motivation (Tough, 1971, pp. 95-97)

For Brockett and Donaghy (2005), Tough's study of self-planned learning reflects a conceptual maturation within the field self-directed learning. The term "self-planning" itself indicates that: instead of "self-teaching", a term common in the early research on self-direction

which carries connotations of learning strictly from oneself, with no outside help, “self-planning” suggests that reliance on other resources is an integral aspect of self-directed learning (Kasworm, 1992).

The seminal works of Houle and Tough were followed in the 70’s by others that further defined and popularized self-directed learning. Most important among those is Knowles’ *Self-Directed Learning* (1975), which provided one of the earliest comprehensive definitions of self-directed learning: "a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes" (p. 18). Knowles recognized the importance of earlier labels, such as self-planned learning and self-teaching, but found that they did not convey the social nature of self-direction and its reliance on various external helpers.

Knowles posited that his definition of self-directed learning was inextricably linked to *andragogy*, a concept he devised to describe the unique characteristics of the adult learner in an earlier work, *The Ault Learner* (1973). For Knowles, andragogy was a set of four assumptions about the adult learner:

1. Self-Concept: As adults mature, their self-concept moves from being dependent toward being self-directed.
2. Adult Learner Experience: As adults mature, they accumulate experience, which becomes an increasing resource for learning.
3. Readiness to Learn: As adults mature, their readiness to learn becomes increasingly oriented to the developmental tasks of their social roles.

4. Orientation to Learning: As adults mature, their perspective changes from one of postponed application of knowledge to immediacy of application. As a result, their orientation toward learning shifts from subject-centeredness to problem centeredness. (Knowles, 1973)

In a later edition of *The Adult Learner,* Knowles added a fifth assumption:

5. Motivation to learn: As adults mature, their motivation to learn becomes intrinsic, rather than extrinsic (Knowles, 1984).

Another important work in the mid to late 1970's was Guglielmino's self-directed learning readiness scale (SDLRS). One of the first quantitative instruments to measure self-directed learning, the SDLRS is comprised of 58 Likert-scale items that measure the degree to which an adult is ready to engage in self-directed learning. Guglielmino performed a factor analysis on the 58 items and found that the items represented eight factors: love of learning; self-concept as an effective independent learner; tolerance of risk, ambiguity, and complexity in learning; creativity; view of learning as a lifelong, beneficial process; initiative in learning; self-understanding; acceptance of responsibility for one's own learning (Guglielmino, 1977).

Although the SDLRS has been used extensively, researchers have raised significant concerns about the instrument. Most notably, Field (1989) argued that the instrument was conceptually and methodologically flawed to such an extent that its use should be discontinued. Additionally, the construct validity, applicability of the instrument to diverse populations, accuracy of the eight factors, and availability of the survey have been intensely debated (Fisher, King, & Tague, 2001). Nevertheless, the SDLRS remains the instrument most widely used to measure self-direction (Merriam, Caffarella & Baumgartner, 2007).

By the start of the 1980s, self-directed learning was widely studied and regarded as a core aspect of adult education. Throughout that decade, almost every book published in English on adult learning discussed self-directed learning in one way or another (Candy, 1991). That surge in interest stemmed partly from the perception that self-direction was a hallmark of the adult learner (Mezirow, 1985) and "the long-term goal of most, if not all, educational endeavors (Candy, 1991). In fact, Knowles considered self-direction as one of the distinguishing characteristics of the adult learner as early as 1973, when he outlined the concept of andragogy in *The Adult Learner*.

The importance of self-directed learning as a research topic and the sheer number of studies focused on that subject led to increased scrutiny. For instance, in a critical review of the literature on self-directed learning, Brookfield (1985) argued that studies often displayed a lack of variety both in their methods, "quasi-quantitative" instruments that closely resembled those used by Tough and his associates in early studies, and in the populations they targeted—usually middle-class and well-educated (p. 12). He was concerned that self-directed learning was becoming an "orthodoxy" (p. 5) and an idea often accepted uncritically in the study of adult education. Brookfield was also skeptical of the idea of self-directed learning as solely the "command of self-instructional techniques". This, he argued, placed too much importance on the instructional methods and not enough on the potential of individuals for critical reflection. In this manner it was "possible to be a superb technician of self-directed learning … and yet never ask whether one's intellectual pursuit is valid or worthwhile" (p. 15). Brookfield advocated that future studies made a distinction between self-direction as an instructional technique and self-direction as an internal shift in consciousness.

Brockett and Hiemstra (1991), despite characterizing Brookfield's view as unnecessarily pessimistic, nevertheless shared the same concerns about the conceptual misunderstandings regarding self-directed learning. They argued that the breadth in research on the field led to confusion about what self-directed learning meant as a construct. Different studies defined "self-directed learning" in different ways, and in some cases, applied that same label to different constructs. After presenting a review of past attempts at identifying the different constructs that fell under the umbrella of "self-directed learning", including Kasworm (1983), Fellenz (1985), Oddi (1987), and Candy (1991), Brockett and Hiemstra arrived at their own *Personal Responsibility Orientation* (PRO) model of self-direction in learning.

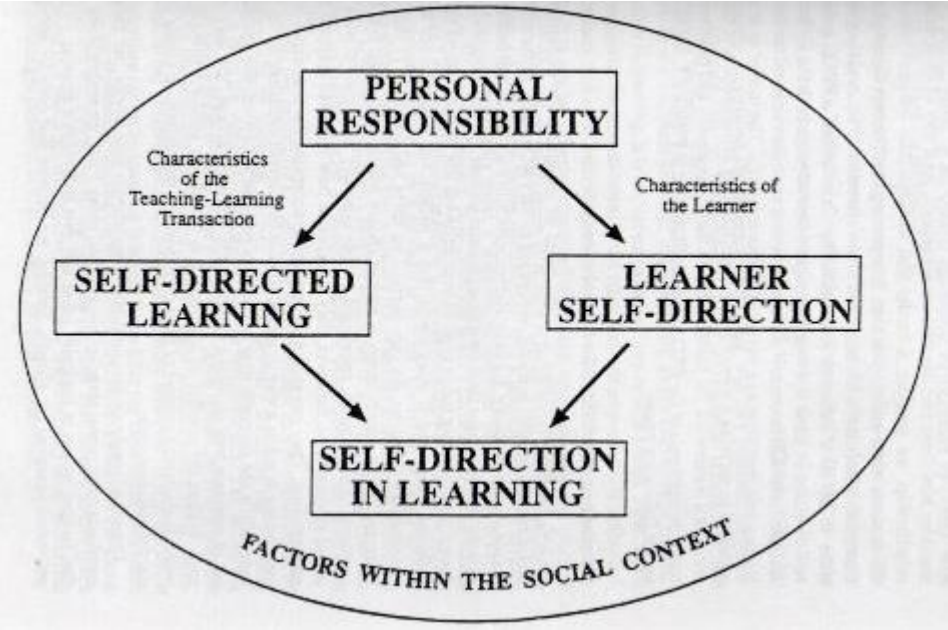

Figure 2.1. The PRO Model

The central distinction the PRO model makes is between *self-directed learning*, an instructional method, and *learner self-direction*, a characteristic of the learner. For Brockett and Hiemstra, self-directed learning is "a process that centers on the activities of planning, implementing, and evaluating learning" (p. 28). This is the exact same process that was described

in earlier scholarship, including Tough's (1971) research and Knowles' (1975) definition. Learner self-direction, on the other hand, refers to "characteristics of an individual that predispose one toward taking primary responsibility for personal learning endeavors" (p. 29). Both these dimensions are anchored in the idea of *personal responsibility,* which means an assumption of ownership for one's thoughts and actions (p. 27). Both the external, process-oriented concept of self-directed learning and the internal, personal-oriented learner self-direction describe the larger phenomenon of *self-direction in learning,* which, as Brockett and Hiemstra note, always happens within a social context. Figure 2.1, above, illustrates this definition.

The Personal Responsibility Orientation to Self-Direction in Learning (PRO-SDLS) is a survey that was developed to measure self-directedness of college students (Stockdale & Brockett, 2011). It is based upon an operational definition of the PRO model and consists of 25 Likert-scale items across four latent variables. The PRO-SDLS was developed in part as an alternative to Guglielmino's (1977) SDLRS. Stockdale and Brockett, while acknowledging the contribution of SDLRS for the field, note the many criticisms on the instrument which have been described earlier in this chapter. As it is the primary instrument used in this study, PRO-SDLS, its four latent variables, and the operational definitions it uses will be described in more detail in the methods section of this text.

By the mid-1990s, self-direction in learning was a mature area of research within adult education. Enough time had passed since the publication of its foundational works to allow for critical perspectives such as Brookfield's (1985), and the discussions they prompted (Brockett, 1985) led to broader and more nuanced outlook on self-direction. Around that time, personal computers and the internet were becoming more and more accessible for a larger portion of the

population. This brought exciting new possibilities and radical change for self-directed learning (Fischer & Schaff, 1998; French, 1999). As such, the interplay between self-directed learning and technology has been a significant focus of research for the past 20 years.

The following studies provide an indication of the breadth of research on self-direction and technology. Hiemstra (2006) has studied the experience of internet learners who lived in rural areas. Bonk, Lee, Kou, Xu and Sheu (2015) studied the learning goals, preferences, and challenges of learners using the Massachusetts Institute of Technology's (MIT) OpenCourseWare – an initiative which publishes all course content from MIT on the internet, for free. Lai (2015) examined how to teach the use of technology for self-directed learning. Lastly, Rashid and Asghar (2016) found that students who used technology extensively tended to be more self-directed.

Computer Science and Self-Direction

According to Boyer, Langevin, and Gaspar (2008), "computing professionals are required to leverage self-direction in their lifelong learning in order to constantly adapt to new emerging technologies" (p. 1). This is such an oft-repeated notion that Zander, Boustedt, Eckerdal, McCartney, Sanders, Moström, and Thomas call it an "accepted wisdom" (2012, p. 111) within the field. While it is true that the need to learn in order to stay current applies, to some degree, to all professionals, this is especially true of computing professionals due to the nature of their work (Zander et al., 2012). Technology brings about rapid and sometimes fundamental change, which means computing professionals have a particularly strong need for self-direction.

The work of Zander et al. (2012) shows how prevalent and important self-direction is for computing professionals. In an interview with ten computing professionals, self-direction was mentioned as an essential skill in the workplace. According to these professionals, self-direction

is implicitly expected of new hires and is also key for continued success in the field. Most of the interviewees regarded themselves as competent self-directed learners and were proud of their learning endeavors. However, they also expressed negative feelings toward self-directed learning. In some cases, the motivation for a self-directed learning experience stemmed from immense pressure to complete a project, or from a sense of intimidation that they did not know as much as their peers. The constant need for self-direction could also lead to burnout or insecurities about staying relevant as a professional.

Despite being fundamentally important for computing professionals, self-direction is not often taught to college students of computer science, and fundamental skills in the discipline, such as programming, are usually taught through lectures and other teacher-centered instructional methods (Tirronen & Isomöttönen, 2012; Noor, Harun, & Aris, 2014). This is due, in part, to the complexity of the subjects. Programming, for instance, is considered hard to learn (Noor et al, 2014), especially for students with no prior experience. Ponti (2013) shows that beginner programmers can struggle with self-direction and might express a desire for guidance.

In summary, self-direction is an essential skill for computer science professionals, but it is not widely used as an instructional method in formal educational settings. Research on the intersection between computer science and self-direction reflects this lack of widespread use, as there is not a comprehensive or influential theoretical work in that research area, and, for the most part, the articles do not reference each other. Research on computer science and self-direction can be categorized according to four approaches:

1. Research on the impact of self-directed learning methods on student learning and performance.
2. Development of instructional methods that foster self-direction.

3. Research on problem-based learning and its influence on self-direction in learning.
4. Studies that attempt to measure learner self-direction directly or as consequence of a related characteristic (such as preference of andragogical teaching methods).

These four approaches will each be analyzed below. But before that, it is important to define and distinguish self-direction from a related concept.

Self-Regulated Learning

This literature review identified a rich body of literature on self-regulated learning within programming and computer science (Bergin, Reilly, & Traynor, 2005; Lenne, Abel, Trigano, & Leblanc, 2008; Çakıroğlu & Öztürk, 2017; Garcia, Falkner & Vivian, 2018).

Self-regulated learning is a theory of learning rooted in cognitive psychology that seeks to analyze how learners independently regulate their cognition, motivation, and behavior during the learning process (Saks & Leijen, 2014). This definition bears similarities to self-directed learning theory, and, indeed, scholars have found significant links between the two theories (Pilling-Cormick & Garrison, 2007). However, there are also significant differences. Jossberger, Brand-Gruwel, Boshuizen and Wiel (2010) argue that self-regulated learning describes learning at the micro-level, with particular attention given to the metacognitive processes that learners employ. Self-directed learning, on the other hand, views learning on a macro-scale, and for that reason it accounts for phenomena (such as the planning of the learning process) that fall outside the scope of self-regulated learning. To Jossberger et al., self-regulated learning is contained within self-directed learning. In this way, it would be possible for a learner to be self-regulated, but not self-directed.

The studies on self-regulated learning within computer science that we identified reflect Jossberger et al.'s distinction. These studies tend to deal with the strategies employed by students in order to make sense of homework and content they learned in class. This is also in line with Saks and Leijen's (2014) review, which identified that studies on self-regulated learning tended to prioritize learning that occurred in a school environment, with tasks usually determined by a teacher. By contrast, self-directed learning usually encompasses learning practiced outside a traditional school environment.

Although the population for this study is comprised of students in a formal educational setting, this study is interested in their potential for broader self-direction, rather than the metacognitive processes that are tied more directly to what they learn from their professors. For this reason, we will not focus on self-regulated learning in this review of the literature.

Impact of Self-Directed Learning Methods on Student Learning

Ellis (2007) surveyed student reactions to a self-directed approach to a Web-application design and development course. The course supported self-direction in two ways. First, it featured a student-defined team project. In this project, students were tasked to develop a web-application directed at any topic of their choosing; past examples included on-line weather prediction and terrorism response planning sites that supported self-direction. This project accounted for 60% of their final grade. Second, students used a self-grading scheme to assess their web-application; the professor could make small alterations to the final grade. Students were surveyed about their satisfaction twice: at the fourth week and at the end of the semester. The results indicated "a high degree of student satisfaction with both the self-determined approach and the course overall" (p. 60). Additionally, 91% of students achieved a grade of A or B on the course, indicating that they had mastered the content of the course. The instructor also

noted that the student-determined projects were more complex compared to past offerings of the course, when all students implemented the same, teacher-determined application.

Brannan, Marley, Fallon, & Bower (2014) incorporated a self-directed learning module to a computer applications course offered to civil engineering sophomore students. In the module, students received an assignment. In order to complete that assignment, students would need to learn a programming concept that had not been introduced or discussed previously during the class. The module also taught students about lifelong and self-directed learning. At the end of the semester, students were surveyed about their experiences. Students indicated a high degree of satisfaction with the module and indicated that it helped develop their self-directed learning skills.

Teaching Methods

A number of studies focus on the development of teaching methods that foster self-direction, either for engineering students in general (Böhne, Faltin, & Wagner, 2002; Fellows, Culver, Ruggieri & Beston, 2002; Miller, DeClerck, Endres, Roberts, Hale, & Sorby, 2013) or for the teaching of computer programming specifically (Tirronen & Isomöttönen, 2012; Dichev & Dicheva, 2013).

Problem-Based Learning

Another area of focus is *problem-based learning* (PBL), which has been shown to contribute to self-direction for learners of computer science (LeJeune, 2002; García-Famoso 2005; Havenga, 2015). PBL can be defined as "learning by solving a large, real-world problem" (Barg, Fekete, Greening, Hollands, Kay, Kingston & Crawford, 2000, p. 111). PBL goes beyond simply using problems to illustrate or further explain concepts. Instead, it places problem-solving at the center of the learning experience (Barg et al., 2000). While it has originated in medical

science, PBL has been used in other disciplines such as education and engineering (LeJeune, 2002).

PBL involves approaching a problem with no previous preparation. It requires learners to analyze the problem, determine and locate resources to use, justify a potential solution, and, in general, take responsibility for their own learning. (García-Formoso, 2005). These steps show clear links to self-direction in learning, and in fact closely resemble those outlined by Tough (1971) in his description of the self-directed learning process.

Measuring Self-Direction

Several studies have measured self-direction among learners of computer programming. Three of these studies (Chou, 2012; Noor et al., 2014; Álvarez, Fajardo, Meza, & Vásquez, 2019) targeted non- learners of computer programming who were not computer science majors. Another study (Boyer et al., 2008) targeted computer science majors and surveyed students using the PRO-SDLS. This study closely resembles the present research, and for that reason its results will be described in greater detail.

Chou (2012) examined the correlation between SDLRS scores and learning outcomes in a programming course taught online. The participants were 38 students of electrical engineering in a Taiwanese university. The study found no significant differences in learning outcomes based on SDLRS scores. The mean SDLRS score was 205.5, which is considered average for adults according to Guglielmino (1977).

Noor et al. used an independently developed instrument, based on Delahaye, Limerick, and Hearn's (1994) four stages of learning, to determine learning preferences among learners of programming who were not computer science majors. The participants were 262 students enrolled in an introduction to programming course at a Malaysian university. The research found

that learners displayed high learning orientations for both pedagogy and andragogy. The researchers concluded that, although these learners displayed enough self-direction to work independently, they were still not prepared to take full responsibility for their learning and required guidance from their professors.

Álvarez et al. (2019) surveyed 1694 students taking an introductory programming course at a Chilean university. These students were enrolled in a variety of STEM majors, including informatics, civil engineering, and mechanical engineering. The survey included a modified version of the SDLRS, which the authors further subdivided into five constructs: planning, wish to learn, self-confidence, self-management, and self-evaluation. Out of all majors, informatics majors displayed the highest wish to learn scores. The remaining four constructs saw comparatively small differences across STEM fields. Researchers also compared differences between male and female participants and found that males scored higher in the wish to learn construct than females.

Boyer et al. (2008) surveyed 15 computer science learners at a four-year institution in the state of Florida. Of the 15 participants, 8 were enrolled in an introductory and 7 in an intermediate computer programming course. According to the researchers, most participants were non-traditional students who had transferred from two-year institutions, and who attended classes at night and worked during the day.

These participants were surveyed using the PRO-SDLS. The 8 students in the introductory course received an additional open-ended question, which asked them to provide complementary feedback on how the course influenced their self-direction. Participants took an average of 15 minutes to complete the survey.

Table 2.1

PRO-SDLS Results

	Mean	St. Deviation	Minimum	Maximum
Introductory Course (N=8)	93.75	13.38	72.00	112.00
Intermediate Course (N=7)	85.00	8.93	71.00	95.00
Combined Courses	89.67	12.00	71.00	112.00

The study found that all students scored in the moderate to high range for all four factors in the PRO-SDLS. Students in the introductory course scored higher means than students on the intermediate course. On average, students in the introductory course scored higher than students in the intermediate course for all factors except motivation.

Table 2.2

Factor PRO-SDLS Scores

	Teaching Learning Transaction Component		**Learner Characteristics Component**	
	Initiative – 6 Questions	**Control – 6 Questions**	**Self-efficacy – 6 Questions**	**Motivation – 7 Questions**
	High – 24-30 Moderate – 15-23 Low – 6-14	High – 24-30 Moderate – 15-23 Low – 6-14	High – 24-30 Moderate – 15-23 Low – 6-14	High – 28-35 Moderate – 16-27 Low – 7-15
Introductory Course (N = 8)	24.13 – High	22.00 – Moderate	24.25 – High	20.63 – Moderate

Intermediate Course (N = 7)	19.29 – Moderate	20.00 – Moderate	21.14 – Moderate	21.14 – Moderate

Conclusion

This literature review has provided a historical perspective of the study of self-direction in learning within adult education. It identified the seminal works of Houle (1963) and Tough (1971), the evolution of definitions for self-direction in learning, critical perspectives of self-direction in learning, the development of the PRO model, and the PRO-SDLS, a quantitative instrument based on the PRO.

This review then provided an overview of the literature on self-direction for computer science learners. Specifically, it identified several studies, but found no central, influential works upon which these studies were based. It categorized the research on self-direction in learning in four approaches: the impact of self-directed learning methods on student learning and performance, development of instructional methods that foster self-direction, problem-based learning, and measures of learner self-direction.

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